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SECTION B, ELECTRICAL ENGINEERING

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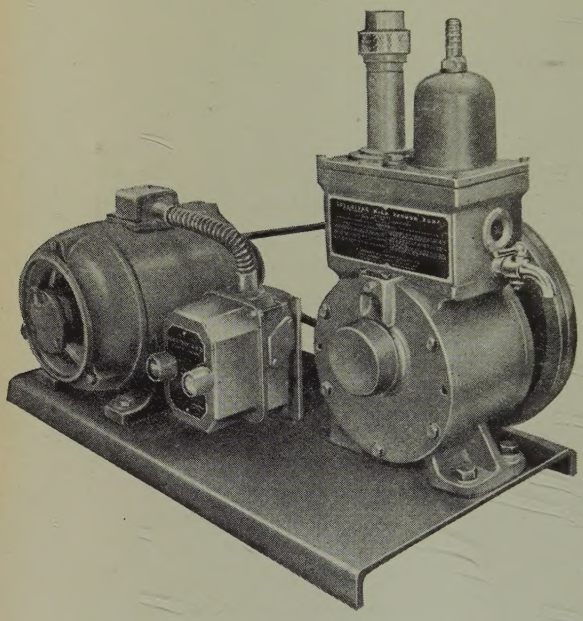

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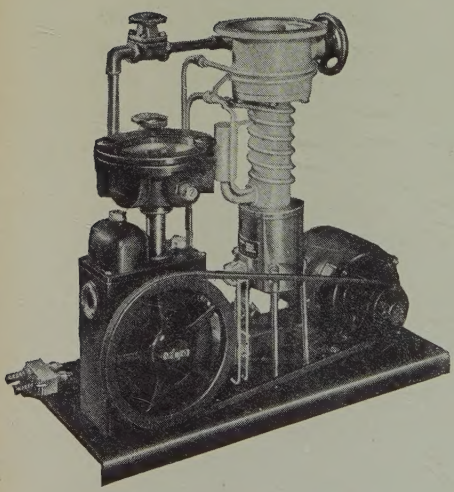

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It is regretted that the articles from which abstracts are made cannot be sent out on loan. Application should be made to appropriate lending libraries or to the publisher of the Journal concerned; publishers' addresses, where known, are given in the "List of Journals" published with the January Number of Vol 53 (1950), or in the supplementary lists published subsequently.

ERRATA (1949)

Abstr. 6988, line 11: *for* $BaTiO_3$ *read* $BaTiO_3$.

ERRATA (1950)

Abstr. 1854, line 3: *for* JANEAU, L. *read* JAUNEAU, L.
Abstr. 4952, line 8: *for* "Ti and H" *read* "Ti and O".

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MATHEMATICS 51

517.5 : 517.6

81. A short table of Struve functions and of some tegrals involving Bessel and Struve functions. C. W. ORTON. *J. Math. Phys.*, **29**, 56–8 (*April*, 1950).

The tables are of: (1) $H_n(z)$ for $n = 2(1)4$, $z = 0{\cdot}1)10{\cdot}0$; (2) $C_n(z) = \int_0^z z^n J_n(z)dz$, for $n = 1(1)4$, $= 0(0{\cdot}1)10{\cdot}0$; (3) $D_n(z) = \int_0^z z^n H_n(z)dz$ for $n = 1)4$, $z = 0(0{\cdot}1)10{\cdot}0$. In each case values are given four places of decimals. L. S. GODDARD

517.6

582. Tables of integrals of Struve functions. L. ABRAMOWITZ. *J. Math. Phys.*, **29**, 49–51 (*April*, 950).

The tables give the values of the integrals of $H_\nu(x)$ nd $L_\nu(x)$ from 0 to x, for $\nu = 0,1$ in the region $= 0$ to $x = 10$ at intervals of 0·1. These integrals rise in certain problems of diffraction [see Abstr. 842 (1949)]. L. S. GODDARD

517.947.43

683. On the elementary solution of the heat equation. M. KRZYŻANSKI. *Atti Accad. Naz. Lincei R.C. Cl. Sci. Fis. Mat. Nat.*) **8**, 193–9 (*March*, 1950) *n French.*

The solution $u(x, y) = y^{-\frac{1}{2}} \exp.(-x^2/4y)$ of the quation $\partial^2 u/\partial x^2 = \partial u/\partial y$ is shown to be the only olution regular for $y \geqslant 0$ such that $\int_{-\infty}^{\infty} u(x, y)dx$ is ounded, $u(x, 0) = 0$ for $x \neq 0$, and $u(x, y) \geqslant 0$.

R. A. NEWING

518.1

684. The best determination, by the condition of east inaccuracy, of a function of the coefficients of an xperimental curve. P. VERNOTTE. *C.R. Acad. Sci., aris*, **230**, 2267–8 (*June* 26, 1950) *In French.*

518.2

685. Tables of the binomial probability distribution. *Vat. Bur. Stand., Appl. Math. Ser.* (*No.* 6) 385 *pp.* 950).

Topics discussed are: (1) Method of preparation of he tables; (2) use of interpolation; (3) applications. here are 2 tables. The first gives the values, to 7 ecimal places, of the terms $(n/r)p^r q^{n-r}$, where $= 0{\cdot}01(0{\cdot}01)0{\cdot}50$; $q = 1 - p$; $n = 2(1)49$; $r = 1)(n - 1)$. The second table gives the values of the artial sums $\sum_{s=r}^{n} (n/s)p^s q^{n-s}$. L. S. GODDARD

518.4 : 535.39

Graphical study of the theoretical optical properties thin films. *See Abstr.* 7906

518.5 : 519.24

7686. A simple integrating device for the routine statistical analysis of recorded data. J. R. GERHARDT. *Trans. Amer. Geophys. Un.*, **31**, 183–6 (*April*, 1950).

The exorbitant amount of labour involved in the routine statistical analysis of recorded data can be reduced considerably by the use of a simple integrating mechanism. For thermistor measurements of temperature in particular, a series of ten electric clocks controlled by contacts on a 50-pole commutator, each of whose poles is equivalent to a temperature change of 0·5°C, indicates the time that the temperature has remained within any of ten successive 0·5°C intervals. Two calculations are all that are then required to obtain the mean and standard deviation of the original record. The maximum response delay of the equipment is about four seconds for temperature changes up to 5°C. Sample statistical analyses are presented. A.

518.5 : 621.317.39

7687. Reactive circuits as computers and analogues. D. A. BELL. *Electronic Engng*, **22**, 232–5 (*June*, 1950).

The principles of reactive circuits, in contrast to digital computers, are explained briefly, and their application to (1) addition and subtraction, (2) multiplication of a variable by a constant, (3) differentiation and integration, (4) multiplication of two variables is discussed. The operational methods available are: mechanical (servo-driven potentiometers), electronic (multiplying devices such as modulators and exponential-law devices such as barrier-layer rectifiers), electromechanical (masks inside c.r.t.'s) and by "crossed fields" and beams (fields and electron beam in a c.r.t.). Some of the basic circuit elements for computers and analogues (these are simulators, causing current or voltage to vary with time in analogy with a mechanical property of the observed system) are described, with particular emphasis on the application of negative feedback as a stabilizing and linearizing factor. A. LANDMAN

519.271

7688. A sampling method for determining the lowest eigenvalue and the principal eigenfunction of Schrödinger's equation. M. D. DONSKER AND M. KAC. *J. Res. Nat. Bur. Stand., Wash.*, **44**, 551–7 (*May*, 1950).

Preliminary report. The theory underlying the procedure is explained and two cases treated numerically. Although the initial results are encouraging, more experimentation will be needed to fully test the practicality of the method. A.

519.283 : 539.185.7

Random sampling [Monte Carlo] techniques in neutron attenuation problems. *See Abstr.* 8248

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.612 : 523.842

689. On the photometry of double stars. H. IENLE. *S.B. Dtsch. Akad. Wiss. Berlin* (*Math.-Nat.* .) (*No.* 6) 17 *pp.* (1949) *In German.*

A new double star photometer has been designed and built, mainly during the years 1940–43, particularly for use with the 80 cm refractor of the Potsdam Observatory; war conditions prevented its further development. It succeeded in achieving an accurate photographic photometry of those close

pairs which can visually be separated without difficulty. A bi-prism of 162° produces two light-paths separating the two double star components on the photographic plate by 7·5 mm; a calibrated wedge is inserted to equalize their brightness, i.e. to measure their fundamental intensity difference. A separate investigation deals with artificial companions produced by a special adjustable grating ("Jalousiegitter"), and which should be introduced into a secondary light path. Turning of the grating changes the separation of the stars, and variation of the inclinations of their lamels their brightness. A combination of the optical separation method and the bi-prism arrangement with spectrophotometric analysis permits the extension of the measurements to very close binary systems, near to the limit of possible optical separation. Its future use in the Cassegrain focus of a reflector is recommended. A. BEER

523.1

7690. Derivation of fundamental astronomical constants from the observations of Eros during 1926–1945. E. RABE. *Astron. J.*, **55**, 112–26 (*May*, 1950).

523.1

7691. A new approach to cosmology. I. A. E. H. BLEKSLEY. *S. Afr. J. Sci.*, **46**, 343–6 (*July*, 1950).

A theory based on certain broad axioms, in particular an axiom of operational definition (epistemological axiom). Certain consequences of these axioms are traced: (i) the age (T) of the universe is finite; (ii) the radius (R) of the universe is finite; (iii) the number of protons (N) in the universe is finite; (iv) there exists a shortest meaningful distance in the universe, $\rho = \frac{1}{2}R/N$, which is identified with the diameter of the proton; (v) there exists a shortest meaningful period of time in the universe, $\tau = \rho/c = 0{\cdot}9 \times 10^{-23}$ sec, i.e. time, like space, is quantized. A.

523.1 : 536.75

7692. Is the increase of entropy in an infinite universe absolute? YA. P. TERLETSKIĬ. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 6) 1041–4 (1950) *In Russian.*

523.161

7693. The size of interstellar clouds. W. H. MCCREA. *Observatory*, **70**, 100–3 (*June*, 1950).

The total number of clouds may be considerably greater than that of clouds large enough to produce detectable absorption lines. Clouds are treated as spherical, the number $N(r)$ per unit volume with radius r being a function of r. Clouds are detectable if $r > l$. Observational data, used for illustrative calculations with $N(r) \propto e^{-r/R}$, give $l \sim 6$ parsecs, and the mean radius $R \sim 3{\cdot}8$ parsecs. It is suggested that a significant proportion of clouds have masses of the order of stellar masses. R. A. NEWING

523.161 : 531.51 : 530.12

A possible mechanism of capture of cosmic dust by the sun. *See Abstr.* 7725

523.161 : 538.12 : 537.591.1

7694. Interstellar magnetic fields. A. SCHLÜTER AND L. BIERMANN. *Z. Naturforsch.*, **5a**, 237–51 (*May*, 1950) *In German.*

The differing motions of ions and electrons in turbulent interstellar gas will generate a magnetic field which at first increases exponentially with time. Interaction between the field and turbulence inhi further increase in field strength. The expec strength in the Milky Way is of the order of 10^{-6} ga The relation of these results to theories of cosmic r is discussed. R. A. NEW

523.165 : 523

7695. The diffraction of solar and cosmic radio-no on the moon. G. G. GETMANTSEV AND V. L. GI BURG. *J. Exp. Theor. Phys., USSR*, **20**, 347 (*April*, 1950) *In Russian.*

Deals with a problem of radio-astronomy, viz. comparatively low angular resolving power receiving systems, whether operated with single spaced aerials. In the best of cases, i.e. with an ae raised to about 1·5 km above ground or sea level, separation obtainable is about 3′, which is qu insufficient to localize the origin of an individual no signal. E.g. referring to a certain nebula of dim sions of the order 5′, it is impossible to say whet the noise is due to the nebula as a whole or a individual star or star group in it, especially since dimensions of even the nearest stars do not exc 0·1″. The suggested method, using diffraction the radio waves on the limb of the moon, is sho to improve these conditions, so that in cert favourable circumstances separations of the order could be obtained. The method can only be us for solar observations during eclipses, and for cosm objects only when they are covered by the moo A further refinement may on principle be achieved "central-spot diffraction," though the experimen difficulties would be far greater. B. F. KRA

523

7696. Photometric measures of zodiacal lig A. COLACEVICH AND L. VIVIANI. *Atti Accad. N Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **8**, 224–6 (*Mar* 1950) *In Italian.*

After discussing the difficulty of obtaining spec of the zodiacal light, the authors give the results their measurement in the form of isophotes of phot graphs of the zodiacal light obtained by Dauvil at the Pic du Midi in December 1943 and Februa 1944. The effect of twilight cannot be altogeth eliminated in the photographs especially near t horizon. V. C. A. FERRA

523.

7697. Non-homogeneous temperature radiation a its application to the sun. II. Y. SUZUKI. *Pu Astron. Soc. Japan*, **1** (*No.* 4) 109–13 (1950).

Due to random deviations about a most probab temperature of the turbulent photosphere, the therm radiation may be considered as non-homogeneo temperature radiation, the general properties of whi have been examined by the author [*Publ. Astron. So Japan*, **1** (*No.* 1–2) 33 (1949)]. The results of t analysis are applied to the sun to explain departur from Planck's law. Excitation and ionization in t chromosphere by this radiation is examined. M. W. OVENDE

523.7

7698. Origin of sunspots. D. H. MENZEL. Letter *Nature, Lond.*, **166**, 31–2 (*July* 1, 1950).

It is shown that in an ionized gas moving in magnetic field the lines of force move with the materia

ouds of ionized gas, ejected from the sun in spicule tivity, may cascade back to the uator, thus producing an intensification of the sumed general magnetic field of the sun at the points influx. The downfalling material will flow out yay from the magnetic cores to produce cooling.

M. W. OVENDEN

523.75 : 523.165

99. On the origin of the cosmic radiation from the n. K. O. KIEPENHEUER. Letter in *Phys. Rev.*, **78**, 9–10 (*June* 15, 1950).

The particles giving rise to cosmic ray phenomena sociated with solar flares are considered to arise as art of a shielding current developed in interplanetary latter surrounding a corpuscular beam associated ith an entrained magnetic field emitted at a solar are. It is shown that only 1 in 10^7 particles forming he shielding current is required to attain cosmic-ray nergies.

J. G. WILSON

523.752

700. On the equilibrium of the solar chromosphere. . R. MUSTEL. *Contr. Crimean Astrophys. Obs.*, **2** 1948) *In Russian.*

The purpose of this work is to explain the ab- ormally slow decrease of partial density with ncreasing height of the heavier than H elements. t is assumed that the distribution of the partial ensity of H atoms is known. The following inter- retation is found by the author. Various observed acts suggest that condensations of matter, composed f various elements, are being thrown upwards into he chromosphere from the lower layers. These atoms, fter having reached a certain height, are diffused lownwards under the force of gravity. However, owing to a very large percentage of H the speed of iffusion is very small. Thus even at the height of ome 6 000 km the velocity of diffusion W of the Ca II ions (formulae 3 to 5) is found to be of the rder of 6 km/sec. The time of diffusion down to the evel $h = 0$ will be many years. Consequently at a iven level and a given moment, a sufficiently large umber of heavier atoms will be found; this explains low value of β_0. Furthermore, the process described xplains the rapid decrease of the ratio of metallic toms to H atoms with height.

ASTRONOMICAL NEWS LETTER

523.752

701. On the electron temperature of the chromo- phere. S. MIYAMOTO AND I. KAWAGUCHI. *Publ. stron. Soc. Japan*, **1** (*No.* 4) 114–21 (1950).

The hypothesis of the high electron temperature of he chromosphere has been criticized, comparing the ash observation with the theories of the metallic onizations and the emission curve of growth for Ca II, H and K. Our results do not favour the high lectron temperature hypothesis: For the electron emperature as high as 35 000°, the state of chromo- pheric ionization is enhanced by the electron collision nd it resembles those of B- or O-type atmospheres. mission curve of growth for the same temperature oes not conform with the observation. So far as e are concerned with these two subjects, observations re well fitted with the theories, if we assume the hotospheric 6 000°, for the electron temperature of he layer.

A.

523.755

7702. Observations of the solar corona without an eclipse in the 5 303 Å rays. M. N. GNEVYSHEV AND R. S. GNEVYSHEVA. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 4) 659–60 (1950) *In Russian.*

Describes the first photographs of the green emission line 5 303 Å of the solar corona without an eclipse by means of a coronograph installed in Northern Caucasus, 2 130 m above sea level.

F. LACHMAN

523.755

7703. Observation in infrared rays of the solar corona without an eclipse. A. A. KALINYAK. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 4) 661–2 (1950) *In Russian.*

Gives results of photographing the solar corona in infrared rays without an eclipse. This method considerably reduces the effect of the scattered atmosphere light; at the same time lines were observed corresponding to a higher degree of ionization than in the visible region. The photographing of the solar corona was carried out by using an electronic-optical transformer connected with the eyepiece part of the "extra-ecliptic" coronograph. The photographs obtained show that at a distance of 6–7 arc minutes from the edge of the sun a luminescence of highly varying brightness can be observed.

F. LACHMAN

523.76

7704. On the limb-darkening of the sun. I. Second approximation in the Milne–Lindblad theory of the blanketing effect of the reversing layer. Z. HITOTUYANAGI. *Jap. J. Astron. Geophys.*, **19**, 97–111 (1941) *In German.*

Calculations based on a second approximation to the temperature distribution are made for monochromatic and for integrated light. Agreement with observation is considered to be unsatisfactory.

R. A. NEWING

523.76

7705. On the limb-darkening of the sun. II. The influence of Fraunhofer lines on the continuous spectrum. Z. HITOTUYANAGI. *Jap. J. Astron. Geophys.*, **19**, 113–34 (1941) *In German.*

The ratio of the line to the continuous absorption coefficient is assumed to vary with optical depth as $\alpha + \beta e^{-\lambda\tau}$. Calculations are made for various model atmospheres and it is concluded that the observed darkening cannot be explained in terms of purely radiative equilibrium.

R. A. NEWING

523.77

7706. Solar limb effect of the spectral lines in a prominence observed at the total eclipse in 1941. T. TANAKA AND Z. KOANA. *J. Phys. Soc. Japan*, **5**, 95–101 (*March–April*, 1950).

No limb effect was found for the Balmer lines $H\beta$–$H\varepsilon$, or for the He lines 4 713 and 4 471. A residual of $+0{\cdot}106$ Å for the H and K lines is in good agreement with previously-measured values for the limb effect, obtained other than at eclipses. The Balmer and He lines are used to derive a value for the sun's rotational velocity.

M. W. OVENDEN

523.77

7707. On the solar coronal lines at the total eclipse in 1943. T. TANAKA AND H. OURA. *J. Phys. Soc. Japan*, **5**, 101–5 (*March–April*, 1950).

The intensity distributions of the lines 5 303 and

6 374 were measured photographically. The distributions are found to differ between the lines and also between the east and west limbs, but over the range $0{\cdot}2r$–$0{\cdot}4r$ deviations from the distribution of the continuous spectrum are small. For distances less than $0{\cdot}2r$, the coronal distribution curves are flat and show greater deviations from the curve of the continuous spectrum. Intensity maxima were found at $0{\cdot}11r$ for 5 303 and $0{\cdot}17r$ for 6 374. Some fluctuations in the measured wavelengths of the coronal lines is attributed to turbulence.

M. W. OVENDEN

523.77

7708. On the continuous spectrum of the solar corona at the total eclipse in 1943. T. TANAKA, H. OURA, T. MUKAKAMI AND T. MITUNOBU. *J. Phys. Soc. Japan*, **5**, 106–10 (*March–April*, 1950).

An examination is made of the polarization of the continuous spectrum of the corona in the wavelength range 4 200–6 200 Å. The polarization at a given solar height is found to decrease with increasing wavelength, but it is suggested that this may be due to the presence of light cloud, and that no evidence exists for a real difference. The reduced curves are compared with other published data. M. W. OVENDEN

523.77

7709. Supplementary report on the continuous spectrum of the solar corona. T. TANAKA. *J. Phys. Soc. Japan*, **5**, 110–14 (*March–April*, 1950).

The intensity distributions observed in the region 4 200–8 600 Å at the eclipses of 1936 and 1943 are compared. The curves in different wavelengths coincide, but systematic differences between the maximum and minimum type corona are found. Data on polarization given by Cohn [*Astrophys. J.*, **87**, 284 (1938)] for the 1932 and 1934 eclipses are discussed, and it is concluded that any dependency on wavelength is spurious. The effect of sky light on the polarization curves is discussed. M. W. OVENDEN

523.83

7710. Space motion of stars in the vicinity of the sun (third and fourth report). T. SHIMIZU. *Publ. Astron. Soc. Japan*, **1** (*No.* 3) 53–8; (*No.* 4) 128–38 (1949).

The space-motions of nearby stars are examined from the standpoint of the "two groups" hypothesis, the characteristics of the velocity ellipsoids of the two groups being derived. Statistical significance tests are made which do not contradict the hypothesis. Possible differences in the kinematical features between different spectral types and different absolute magnitudes are examined, and the relationship between this hypothesis and Kapteyn's two star-streams is discussed.

[Pt I, *Jap. J. Astron.*, **1**, 48 (1949); Pt II, *Publ. Astron. Soc. Japan*, **1**, 43 (1949)]. M. W. OVENDEN

523.83

7711. Dynamical consideration about the hypothesis of two velocity ellipsoids. T. SHIMIZU. *Publ. Astron. Soc. Japan*, **1** (*No.* 3) 90–6 (1949).

This hypothesis, previously shown to be consistent with statistical results for stars nearer than 20 parsecs [see preceding Abstr.], is examined from the dynamical point of view by a modification of Chandrasekhar's treatment necessitated by the possible influence of local irregularities of stellar distribution. It is concluded that, if consideration is limited to a comparatively small space about the sun and to a short interval of time, a condition of steady state can be assumed, when the hypothesis is, from the dynamical standpoint, consistent with the observed density distribution. M. W. OVENDEN

523.841.9

7712. On the determination of the coefficient of darkening in eclipsing binaries. Y. HOSOKAWA. *Publ. Astron. Soc. Japan*, **1** (*No.* 3) 73–7 (1949).

A simplified method is given applicable to almost centrally eclipsing components. R. A. NEWING

523.852.33

7713. The recession of the extra-galactic nebulae. V. P. DRUMAUX. *Ann. Soc. Sci. Brux.*, **64** (*No.* 1–2) 31–8 (1950) *In French.*

See Abstr. 3576 (1948), 3708–9 (1949). The discussion of the determination of nebular trajectories by Doppler effects is continued. Difficulties arising from uncertainties in absolute magnitudes may be avoided if the variation in magnitude from one nebula to another is known. R. A. NEWING

523.855

7714. Relative diameters of galaxies. H. SHAPLEY. Letter in *Nature, Lond.*, **166**, 192 (*July* 29, 1950).

523.87 : 535.247.4

An integrating photometer for low light levels. *See Abstr.* 7844

523.877

7715. On the stability and oscillations of gaseous spheres and stars. A. B. SEVERNY. *Contr. Crimean Astrophys. Obs.*, **1** (*Pt* 2) (1948) *In Russian.*

The stability was studied by the theory of small oscillations. The stability depends on 3 factors: the chemical composition (which determines $\gamma = c_p/c_v$); the process of generation of energy; and the mode of dissipating the energy. The first of these produces instability when $\gamma < 4/3$; if $\gamma > 4/3$, the star is stable and is able to pulsate harmonically. Dissipating forces (such as turbulence and radiative viscosity) tend to stabilize the star; when $\gamma > 4/3$ pulsations are damped and when $\gamma < 4/3$, these forces retard the instability. This is conditioned by the mean density of the star which, in turn, is a function of its mass. The dissipation of energy in stars of moderate mass is much larger than the excess of heat produced by the nuclear reactions, but in the very massive stars where β tends to 0, any mode of generating energy creates instability.

Stars of very small mass turn out to be always stable. As the mass grows larger, 2 classes with the same effective temperature can be distinguished: diffuse, large stars ($\gamma < 4/3$, $\rho_m < \rho$ critical) and dense small stars ($\gamma > 4/3$). In between, there is the area of instability which gradually disappears with further growth of mass and temperature. In the process of transition over this area and during condensation or expansion of the star, it collapses. White dwarfs form the most advantageous configurations. When masses are very large, however, we enter again into an area of instability caused by the source of energy. The diagram can possibly explain the basic facts of the Hertzsprung–Russell diagram as well as the upper

limit of masses. A low frequency of giants of late classes in our galaxy and the fast evolution of these stars suggest that the ideas of temporary stability of these stars may be correct.

A law connecting the period of free pulsation with the density in Emden spheres has been derived. Computations show better agreement with observations than similar computations of Eddington and of Ledoux and Pekeris. The turbulent damping of pulsations is roughly inversely proportional to the mean density; consequently stars with short periods have, statistically speaking, smaller amplitudes. It is likely that in stars with permanent pulsations the concentration of the sources of energy toward the centre is very high (formula of Atkinson). It has been found analytically that slow rotation of a star makes it unstable with respect to non-radial pulsations. This may lead to the formation of a double star.

ASTRONOMICAL NEWS LETTER

523.877

7716. On the adiabatic equation in stellar atmospheres. Z. HITOTUYANAGI. *Jap. J. Astron. Geophys.*, **21** (*No.* 3) 119–24 (1947) *In German.*

An expression is obtained for the ratio of temperature and pressure increments for a gaseous mixture containing singly and doubly ionized atoms.

R. A. NEWING

523.877

7717. On the determination of the chemical composition of stars. Y. IINUMA. *Publ. Astron. Soc. Japan*, **1** (*No.* 1–2) 18–23 (1949).

Using the mass-luminosity and energy-generation equations, chemical composition can be determined for given values of the ratio of nitrogen to heavy elements. Calculations based on the Cowling model are made for the sun and Sirius. No solution is found for Capella for energy generation by C–N or H–H reactions.

R. A. NEWING

523.877

7718. On the equation of stellar evolution. I. Y. IINUMA. *Publ. Astron. Soc. Japan*, **1** (*No.* 3) 64–9 (1949).

Mass-luminosity and energy-generation equations are used to set up a system of approx. equations giving the time rate of increase of luminosity L, radius R and hydrogen content X. For normal stellar conditions L is found to increase monotonically and R decreases rapidly after an initial period of expansion. Central temperature, mean molecular weight, R, L and X are computed as functions of time for a solar model.

R. A. NEWING

523.877

7719. On the equation of transfer of radiation through a non-grey stellar atmosphere. N. OWAKI. *Publ. Astron. Soc. Japan*, **1** (*No.* 4) 163–70 (1950).

A new method to solve the differential equation of radiative transfer through a non-grey atmosphere is proposed. The analysis is followed along the line of successive approximation given by S. Chandrasekhar. By expanding the equation in terms of Legendre polynomials and applying the Laplace transformation to the resultant simultaneous differential equations, the original equation is reduced to a system of linear algebraic equations, and we can obtain the solution very easily and accurately. This method may be extended and applied to another kind of equation for radiative transfer. The deviation from greyness is found to be in general so small that successive approximation is fairly valid.

A.

523.877

7720. On the abundance of molecular hydrogen in the atmospheres of white dwarfs. P. COUTEAU AND E. SCHATZMAN. *C.R. Acad. Sci., Paris*, **231**, 33–4 (*July* 3, 1950) *In French.*

Tabulated thermal data for H [Abstr. 1440 (1949)] are used to show that the abundance of H_2 is negligible.

R. A. NEWING

523.877 : 539.155.2

7721. The C^{12} to C^{13} abundance ratio in stellar atmospheres. A. MCKELLAR. *Publ. Astron. Soc. Pacif.*, **62**, 110–12 (*June*, 1950).

The new laboratory data of Hall and Fowler [Abstr. 4341 (1950)] lead to a ratio of 5 : 1 for the slow-neutron cross-sections $C^{13} : C^{12}$, the ratio previously being supposed to be about 50 : 1. It is therefore suggested that the primitive matter had an abundance ratio of about 90 : 1, which remains at about this figure in the atmospheres of a few *R*-type stars in which either the C–N cycle does not operate or in which mixing has not taken place. The majority of *R*-type stars which show an abundance ratio of 3·5 : 1 may be considered as those in which the cycle and mixing has operated.

M. W. OVENDEN

525.35 : 550.3

7722. Indication of a correspondence between geophysical phenomena and the motion of the pole. T. NICOLINI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **8**, 348–55 (*April*, 1950) *In Italian.*

A study which seeks to investigate the possible influence of geophysical phenomena, especially meteorological conditions, on the Chandlerean motion of the pole. The results are interesting but do not seem very conclusive.

V. C. A. FERRARO

526.16

7723. New formulas for systems of deflections of the plumb-line and Laplace's theorem. F. A. VENING MEINESZ. *Bull. Geod.* (*No.* 15) 33–42 (1950).

This paper deals with changes in the deflection of the plumb-line caused by a shift of the reference-ellipsoid. Laplace's theorem by which the deflection in any arbitrary azimuth is related to the deflection in longitude is considered and it is shown that in practice measurable deviation from it cannot occur. The validity of Helmert's formulae for systems of deflections are then examined and are shown to be incorrect. The reasons for this and some implication to practical geodetic surveying are given.

B. C. BROWNE

PHYSICS 53

53.081

7724. Atomic definition of primary standards. R. D. HUNTOON AND U. FANO. *Nature, Lond.*, **166**, 167–8 (*July* 29, 1950).

Attention is directed to the possibility of adopting a complete set of atomic standards and to the various questions related to this problem. It is suggested that the atomic metre be defined as the length equal to 1 831 249·2 wavelengths from the 5 460·7532 Å line of Hg^{198} in standard air; the atomic second as the time required for $238\,701 \times 10^5$ oscillations of the 23 870 Mc/s line of NH_3; and that the third basic standard be based on the absolute measurement of the gyromagnetic ratio of the proton. Suggested definitions of the atomic ampere, newton, coulomb and kilogram are also given. S. WEINTROUB

FUNDAMENTALS 530.1

530.12 : 531.51 : 523.161

7725. On the non-conservative property of the photo-gravitational field and on a possible mechanism of capture of cosmic dust by the sun. V. V. RADZIEVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 5) 861–4 (1950) *In Russian.*

530.145

7726. Examples of application of the representation of fundamental ideas of mechanics by unilateral functions. L. MOTCHANE. *C.R. Acad. Sci., Paris*, **230**, 2264–6 (*June* 26, 1950) *In French.*

Two examples—the harmonic oscillator and the spherical rotator—of quantization without the use of the wave equation. Physical quantities are represented by functions defined unilaterally and indefinitely differentiable on the left. A quantity s is expanded in a Taylor series in terms of functions of a parameter q, $s = \psi(q) + s_0 + qs_1/1 + \ldots + q^n s_n/n + \ldots$; $\psi(q)$ is continuous and all s_n are step-functions. For the harmonic oscillator the results give an exact analogue with de Broglie–Schrödinger calculations. J. JACOBS

530.145

7727. On the theory of non-local fields. J. RAYSKI. *Acta Phys. Polon.*, **10** (*No.* 1–2) 103–5 (1950).

A correspondence is set up between non-local and local fields for particles of spin zero. In this way a Hamiltonian and an expression for the charge density are found, and the interaction between two such fields. In the self-energy example discussed the effect of the non-local formalism is to introduce a convergence factor into an otherwise divergent expression.

G. J. KYNCH

530.145

7728. Further remarks on the diagonalization of the Hamiltonian in the theory of wave fields. B. FERRETTI. *Nuovo Cim.*, 7 (*No.* 3 *bis*) 375–7 (*May*, 1950) *In Italian.*

The treatment given in a previous paper [see Abstr. 3759 (1950)] is extended to the case in which the interaction term depends on the derivatives of the field operators. L. PINCHERLE

530.14

7729. A remark on relativistically invariant formulation of the quantum field theory. S. KANESAWA AND Z. KOBA. *Progr. Theor. Phys.*, **4**, 297–311 (*July*–*Sept.*, 1949).

The form of the interaction density, as it occurs in the wave-equation in the interaction representation, is derived from the original Lagrangian and the integrability conditions of this equation. A proof is given that the results are identical with those obtained by the canonical Hamiltonian formulation, when this is possible. Examples are added to illustrate the method, including the Konopinski–Uhlenbeck interaction for β-decay. G. J. KYNCH

530.14

7730. On field theories with non-localized action. A. PAIS AND G. E. UHLENBECK. *Phys. Rev.*, 79, 145–65 (*July* 1, 1950).

It is investigated whether suitable generalizations of the field equations of current field theories to equations of higher order may be of help in eliminating the divergent features of the present theory. It turns out to be difficult, if feasible, to reconcile in this way the requirements of convergence, of positive definiteness of the free field energy, and of a strictly causal behaviour of the state vector of a physical system. Progress may perhaps be made by relinquishing the condition of unlimited localizability of any space-time event. A

530.145

7731. A note on commutators in quantized field theories. S. SCHWEBER. *Phys. Rev.*, **78**, 612–13 (*June* 1, 1950).

It is shown that the commutators of quantized field theories are not uniquely determined by the specification of the Hamiltonian and the field equations and the requirement of Lorentz invariance. However, this lack of uniqueness cannot be used to obtain a high frequency cut-off as in the non-relativistic case. A.

530.145

7732. A note on the invariant formulation of the quantum field theory. J. RAYSKI. *Acta Phys. Polon.*, **10** (*No.* 1–2) 29–31 (1950).

The Schrödinger equation is written in a relativistically invariant form in the general case where the interaction-energy density is not a scalar. The invariance may be exhibited without introducing a generalization called "infinitely-many-time formalism." The autonomy of the formulation of Tomonaga, i.e. its independence of the Lagrangean and Hamiltonian formalisms, is emphasized. A.

530.145

7733. On some phase-potential relations. B. HOLMBERG. *K. Fysiogr. Sallsk. Lund, Forh.*, **20**, *Paper* 4, 9 *pp.* (1950).

These relations are derived in the process of transforming to the momentum representation, and their analogies for discrete states are given when they exist. An extension of Froberg's 1st approx. formulae are given for a non-central potential. Abstr. 1771 (1948).

G. J. KYNCH

530.145

7734. Relativistic covariance in the quantum electrodynamics. J. YUKAWA, N. ODA AND H. UMEZAWA. Letter in *Progr. Theor. Phys.*, **5**, 320–1 (*March–April*, 1950).

530.145

7735. On the application of Feynman's method to the Bremsstrahlung. M. CINI AND L. A. RADICATI. *Nuovo Cim.*, **7** (*No.* 3 *bis*) 380–3 (*May*, 1950) *In Italian.*

Feynman's method was devised to eliminate the usual divergences in quantum electrodynamics. The present paper investigates what modifications are produced by this method on processes in which divergences do not appear. It is found that the main effect in the case of the Bremsstrahlung of an electron in the field of a nucleus is to make more probable—at high energies—the emission of several photons, all with energies $E = \lambda^2/2m$ ($h = c = 1$), where $1/\lambda$ is the cut-off distance. In the case of the Compton effect, the cross-section shows a sharp resonance maximum when the energy of the incident quantum is $= E$. L. PINCHERLE

530.145

7736. Connection of the non-local fields of H. Yukawa with those which describe particles of spin *f*. M. FIERZ. *Helv. Phys. Acta*, **23** (*No.* 4) 412–16 (1950) *In German.*

It is shown that the non-local fields can be expressed as a superposition of fields describing particles of integral spin f. The explicit connection is given. A correction to a previous work of the author is given [*Helv. Phys. Acta*, **12** (*No.* 1) 3–37 (1939)]. G. J. KYNCH

530.145

7737. On the theory of the generalized Compton effect of particles of spin $\hbar$. G. PETIAU. *C.R. Acad. Sci., Paris*, **230**, 2262–4 (*June* 26, 1950) *In French.*

The effective diffusion section in a generalized Compton effect is derived. A particle of spin $\hbar/2$, whose wave functions are solutions of the Dirac equation, absorbs a particle of spin $\hbar$ and emits one of spin $\hbar$ not necessarily of the same mass. The latter are represented only by plane transversal waves. A limiting case yields the Klein–Nishina formula if account is taken of the motion of the centre of diffusion. J. JACOBS

530.145

7738. On the energy-momentum tensor of the electron. F. VILLARS. *Phys. Rev.*, **79**, 122–8 (*July* 1, 1950).

The 1st-order radiative correction to the energy-momentum tensor of the electron is investigated. In order to avoid the ambiguities connected with the occurrence of divergent integrals a regularization with auxiliary masses is introduced. It is shown that a procedure which is in accordance with the conservation laws necessarily has some of the features of an auxiliary field theory. The method of the present calculation corresponds to an introduction of an auxiliary neutral vector-meson field which is coupled to the electron-positron field with an imaginary coupling constant. A.

530.145

7739. A contribution to the theory of self-energy of the electron. I. ÚLEHLA. *Čas. Pěst. Mat. Fis.*, **75** (*No.* 2) 89–95 (1950) *In Czech.*

Belinfante [Abstr. 5962 (1949)] used Fermi's quantum electrodynamics without the usual elimination of the longitudinal and scalar photons for calculating the self-energy of the electron. The result is not unambiguous. This ambiguity can, however, be eliminated by a suitable definition of the functional of state of the free photon field. The investigation is based on the Lagrangian of the interacting electron and photon fields, quantization of the latter leading to the introduction of the re-defined functional of state of the photon field; the calculus of perturbation may then use Schrödinger's time-free equation, where E, H and ψ are expanded in terms of the parameter e. The result of the perturbation calculus is formally analogous with the expression used by Belinfante. The calculation of the matrix elements then furnishes the materials for the self-energy, the expression of which is logarithmically divergent, similar to that derived by Weisskopf, who also used the elimination of longitudinal and scalar photons. B. F. KRAUS

530.145

7740. Researches on the theory of the Dirac electron. E. DURAND. *J. Math. Pures Appl.*, **28**, 77–135 (1949) *In French.*

A comprehensive treatment. The representation of a certain spinor transformation matrix is given; and the concept of wave function potentials, analogous to electrodynamic potentials, is introduced. These potentials satisfy the equation $(\partial_q^q - k_0^2)\Phi_k = 0$ ($k = 1, 2, 3, 4$) and the Dirac wave functions are related to these by $\psi_k = (\gamma_p\partial^p - \gamma_0 k_0)i\gamma_4\Phi_k$. A general expression for Φ_k is considered and the mathematical properties of the solutions arising from it are investigated. MATHEMATICAL REVIEWS

530.145

7741. On the finite extension of the electron in Feynman's theory. L. A. RADICATI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **8**, 232–4 (*March*, 1950) *In Italian.*

A study of the modifications brought by Feynman's method of relativistic cut-off on Sawada's formulae [see Abstr. 1485 (1950)] giving the self-energy of an electron. To the electromagnetic self-energy is added a term due to a neutral vector field, whose quanta have energy $\sqrt{(k^2+\lambda^2)}$, where $1/\lambda$ is the cut-off distance. L. PINCHERLE

530.145

7742. Connection between the definition of nuclei of Feynman and that of field constants of L. de Broglie. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci., Paris*, **230**, 2073–5 (*June* 12, 1950) *In French.*

It is observed that absorption admits postvision, not prevision, and vice versa for emission. In ordinary Dirac theory a negatron ($E+$) is associated with prevision, a positron ($E-$) with postvision. New definitions are required if the double problem is considered of an electron distributed over $E+$ and $E-$ states; leading to the terms "post- and prevision according to the effect." For photon theory the term "absorption (and emission) according to the effect" is correspondingly introduced, describing absorption for $E+$ waves and emission for $E-$ waves if a photon is distributed over $E+$ and $E-$ states. J. JACOBS

530.145

7743. The magnetic moment of the meson. V. S. VRKLJAN. *Proc. Indian Acad. Sci. A*, **30**, 205–10 (*Oct.*, 1949) *In German.*

Theoretical. This is derived using a combination of de Broglie's fusion method with Darwin's idea of wave-packets. E. P. GEORGE

530.145

7744. On the anomalous magnetic moment of nucleon in vector and pseudovector meson theory. S. HORI AND K. SAWADA. Letter in *Progr. Theor. Phys.*, **5**, 333–4 (*March–April*, 1950).

530.145

7745. Anomalous magnetic moment of the nucleon. E. YAMADA. Letter in *Progr. Theor. Phys.*, **5**, 312–13 (*March–April*, 1950).

530.145

7746. Contribution to the study of the neutron-proton system. M. DEMEUR. *Physica*, **16**, 333–8 (*April*, 1950) *In French.*

The Rarita–Schwinger potential has been investigated with a variable range for the tensor forces, the 4th parameter being adjusted to the magnetic moment of the deuteron. If the width of the well of the central forces is $2{\cdot}8\times10^{-13}$ cm, the only solution is that of Rarita and Schwinger, and the lower limit for the width of the well of the tensor forces is $2{\cdot}66\times10^{-13}$ cm. The cross-section for n–p scattering (kinetic energy of the neutron = 50 MeV) has been calculated on the common Rarita–Schwinger theory with neutral and symmetrical isotopic dependences. The results are: Neutral: $S = 0{\cdot}3458\times10^{-24}$ cm², $\Lambda = 0{\cdot}7867$; symmetrical: $S = 0{\cdot}1442\times10^{-24}$ cm², $\Lambda = 6{\cdot}07$. A.

530.145

7747. Schwinger potential in nuclear forces. F. C. BARKER. *Proc. Phys. Soc., Lond. A*, **63**, 898–909 (*Aug.*, 1950).

The properties of the potential derived from the mixed pseudoscalar-vector meson field are investigated and compared with the experimental data on the 2-nucleon system. An attempt has been made to use methods which are more accurate than those formerly applied to this problem, and some of these may be useful in calculations with other potentials. It is found that agreement with experiment cannot be obtained for any choice of meson masses and coupling constants. A.

530.145

7748. Remarks on the theory of S matrices. T. S. CHANG. *Nat. Peking Univ. Semi-Cent. Vol., Math. Phys. Biol. Ser.*, 81–8 (1948).

The wave matrices ψ and the S-matrices are defined in a relativistic way, from which the unitariness of the S-matrices is immediately deduced. It is pointed out that in the nonrelativistic limit, such S-matrices reduce to the usual one provided that in this limit ψ is assumed to satisfy relations of the type specified. The transformation properties of ψ and S under a Lorentz transformation are studied, and it is shown that ψ cannot be an invariant. No practically useful results, however, are obtained. A.

530.145.61

7749. On a variational method in diffraction and diffusion problems of de Broglie waves. T. KAHAN. *C.R. Acad. Sci., Paris*, **230**, 2075–7 (*June* 12, 1950) *In French.*

With Hulthen L is defined as $\int_0^\infty \psi H\psi d\tau$ where H is the Hamiltonian and ψ the wave function for the problem of 2 particles at a distance r, with interaction potential $V(r)$. In the case of r large, let $V(r) = \sum_{i=0}^{m} V_i$, where the V_i with corresponding solutions ψ_i are known, with phases η_i; then it is assumed $\psi = \sum_{i=0}^{m} a_i\psi_i$ and L is minimized with respect to the coeffs. a_i. The case $m = 2$ is briefly described. J. JACOBS

530.145.61 : 539.153.4

7750. One-parameter approximate wave-function for the fundamental state of atoms with two electrons. P. PLUVINAGE. *Ann. Phys., Paris*, **5**, 145–52 (*March–April*, 1950) *In French.*

The wave-function has the form $\psi(x_1x_2) = \psi^0_{100}(x_1)\psi^0_{100}(x_2)u_k(x_{12})$, where ψ_0 is the hydrogen eigenfunction for the ground state, and u_k satisfies:

$$-\frac{d^2u_k}{dx_{12}^2} + \frac{2}{x_{12}}\frac{du_k}{dx_{12}} - \frac{u_k}{x_{12}} = k^2u_k$$

The energy is $E = 2E^\circ + k^2$, and is minimized with respect to k. The result for the ground state of He is 23·88 eV, in better agreement with the experimental value 24·58 than the value 23·05 obtained by previous well-known one-parameter variational calculations. L. PINCHERLE

530.145.61

7751. Gaussian approximations to wave functions. R. MCWEENY. *Nature, Lond.*, **166**, 21–2 (*July* 1, 1950).

The method of Boys of constructing atomic and molecular wave functions from a complete set of Gaussian functions is related to similar work carried out in momentum space. As the minimum no. of terms is to be used the choice of the most suitable members of the set becomes critical; if terms from different Hermite sets are taken the convergence to the true wave function is rapid. The advantages are that wave functions in coordinate and momentum space are formally identical; and all integrals for Gaussian one-electron functions can be simply expressed. J. JACOBS

530.162

7752. The statistics of honeycomb and triangular lattice. I. K. HUSIMI AND I. SYOZI. *Progr. Theor. Phys.*, **5**, 177–86 (*March–April*, 1950).

(Mathematical.) A simplification of Onsager's theory is indicated and applied to the honeycomb lattice. The operator V is factorized into operators belonging to an abstract algebra H for which a construction is given (to be continued). J. JACOBS

530.162 : 532.511

Statistical mechanical theory of transport processes: the equations of thermodynamics. *See Abstr.* 7764

530.162 : 536.71 : 532.7

Calculation of thermodynamic pressure in quantum statistics. *See Abstr.* 7781

530.162 : 537.3

7753. The statistical analysis of electrical noise. D. K. C. MacDonald. *Phil. Mag.*, **41**, 814–18 (*Aug.*, 1950).

Fundamental criticism is made of two recent papers by Meltzer on electrical noise [Abstr. 1757, 4963 (1950)] on general and particular grounds. Correction of the errors in the analysis also provides an opportunity for a discussion of the fundamental relation between a stochastic equation and the corresponding frequency spectrum of a fluctuating variable. An example taken from the field of classical Brownian movement clarifies the concept of the observable velocity of a particle. A.

530.162 : 538.114

Statistical mechanics of the two-dimensional assembly and the triangular Ising net. *See Abstr.* 8115–16

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.44 : 539.62

7754. The sliding surface. G. I. Finch. *Proc. Phys. Soc., Lond. B*, **63**, 465–83 (*July*); *also ibid. A*, **63**, 785–803 (*Aug.*, 1950).

The 34th Guthrie Lecture delivered to the Physical Society. A review of the existing state of knowledge of what actually takes place when one solid surface slides over another, with or without intervening lubricant, a critical survey of past and current ideas, and an account of the author's own work and that of his school on the subject. Particular attention is paid to the role of the oxide layer on the surfaces and to the lubricant as a carrier of oxidant to the high temperature regions of solid-to-solid contact.

M. R. HOPKINS

MECHANICAL MEASUREMENTS 531.7

531.711 : 535.41

7755. First observations on the metrological qualities of the rays emitted by a non-isotopic mercury [Hg^{198}] produced by transmutation of gold; and comments on the standard of length. A. Pérard and J. Terrien. *J. Phys. Radium*, **11**, 249–54 (*June*, 1950) *In French.*

The use of the wavelengths of certain spectral lines as secondary standards of length, and the essential qualities of such lines for that purpose are discussed. The radiation emitted by a Meggers Hg^{198} electrodeless discharge lamp has been examined with a Michelson interferometer and the radiation compared with that of other elements. The lamp used, shown photographically, was excited by an external 100 Mc/s alternating field and was water-cooled. By rotating the lamp it could be viewed either end-on or broadside. The results showed that the lamp should be used at a temperature $< 30°C$ and in the broadside position. The Hg^{198} green and two yellow lines (5 460·7532, 5 769·5984 and 5 790·6330 Å) were compared with the red cadmium line (6 438·4696 Å). The view is expressed that one of the wavelengths of the spectral lines emitted by say a Kr^{84}, Kr^{86} or Hg^{198} lamp could now be considered by the International Conference on Weights and Measures as a primary standard of length. S. WEINTROUB

531.711 : 621.327.9

7756. Lamps and wavelengths of mercury 198. W. F. Meggers and F. O. Westfall. *J. Res. Nat. Bur. Stand., Wash.*, **44**, 447-55 (*May*, 1950).

The production and extraction of artificial Hg^{198} from Au^{197} bombarded by neutrons is described, and the procedure in making electrodeless lamps with Hg^{198} is given in detail. These lamps are excited by h.f. radio waves; they emit the Hg spectrum entirely free from isotope shifts and hyperfine structures that characterize natural Hg. Fabry-Perot interferometers and a prism spectrograph were employed for measuring, relative to Cd 6 438·4696 Å, the wavelengths of the stronger lines in the visible spectrum of Hg^{198}. Preliminary values for Hg^{198} radiations in normal air are reported as 5 790·6627, 5 769·5984, 5 460·7532, 4 358·3377, 4 077·8383 and 4 046·5717 Å, with probable errors not exceeding ± 0·0001 Å. A.

531.717.3 : 534.154 : 621.385.833

7757. Vibration studies: related to electron microscopy. F. A. Hamm and F. C. Snowden. *Rev. Sci. Instrum.*, **21**, 426–31 (*May*, 1950).

This paper describes a convenient scheme for detecting and measuring vibration as related to the performance of an electron microscope, using a phonograph pick-up arm in conjunction with a cathode-ray oscillograph. After calibration, the oscillographic measurements may be used to determine absolute mechanical displacements. Electron micrographs are included to illustrate the image displacements due to several different amplitudes of vibration. Cognizance of vibration is often necessary, especially in high resolution electron microscopy. This scheme may be used as a guide in high resolution electron microscopy. A.

531.719.1

7758. The determination of radii of curvature by mechanical methods of measurement and a comparison of their accuracies. H. Jensen. *Optik*, **6** (*No.* 5) 261–72 (1950) *In German.*

A brief illustrated review of the various mechanical instruments, including templates, test curves and spherometers. S. WEINTROUB

531.719.1

7759. An optical test and measurement apparatus for very small, flat and spherical surfaces. C. von Hofe. *Optik*, **6** (*No.* 5) 257–60 (1950) *In German.*

Discusses the autocollimator method of measuring the radius of curvature of small surfaces, using a microscope O.G. as the collimator objective and a microscope as eyepiece. Limits to the accuracy obtainable are shown to be (*a*) the large depth of focus due to the small entrance pupil of the system, (*b*) the small overall magnification and (*c*) the difficulty of measuring the movement of the microscope. Surfaces as small as 1·15 mm in diameter can be measured with this apparatus. R. W. FISH

531.776

7760. Stroboscopic measurement of rotational speed. K. STROBL. *Elin-Z.*, **2**, 63–73 (*June*, 1950) *In German.*

The fundamental mathematical relation for the production of a stroboscopic picture is derived. The stroboscope considered consists of two discs, one with suitable markings, the other with slits. [See *Arch. Elektrotech.*, **33**, 100 (1939)]. The similarity to electrical current conversion is briefly discussed. [See *Elektrotech. u. Maschinenb.* (*E u M*) **57**, 210 (1931)]. The application of stroboscopy to the measurement of rotational speed is discussed in detail. The normal arrangement, in which the marked and slit discs rotate with the variable and a known constant speed respectively, is capable of high accuracy within narrow ranges at very low and very high speeds. The inverse arrangement, in which the marked and slit discs rotate with the constant and the variable speed respectively, is not limited in range and can measure from zero up to the highest speed with an accuracy of the order of 1% of the highest speed. Various suggested markings are illustrated or considered numerically. A speed controller, the form of slit disc, and a practical form of hand, inverse arrangement, stroboscopic instrument, which is shown diagrammatically, are briefly discussed.

S. WEINTROUB

531.784

7761. A new torsional dynamometer. N. ERASLAN. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **15**, 124–6 (*April*, 1950) *In French.*

A detailed constructional diagram of an experimental prototype is given and discussed. An optical arrangement utilizing crossed-polaroids is employed to obtain the angular displacement. S. WEINTROUB

MECHANICS OF FLUIDS 532

532.133

7762. The change of viscosity of oils containing high polymers when subjected to high rates of shear. L. G. WOOD. *Brit. J. Appl. Phys.*, **1**, 202–6 (*Aug.*, 1950).

The construction and use of an apparatus for the imposition of rates of shear of at least 10^7 secs^{-1} on oils containing high polymers is described. The apparatus is constructed from standard fuel injection equipment with minor modifications. A series of typical results is reported, showing that a substantial decrease in the intrinsic viscosity of the polymer, and consequently in the viscosity of the solution, can occur on application of rates of shear of the above order. A.

532.51

7763. A contribution to the study of similarity between hydro- and gas-dynamics. S. TEOFILATO. *Monogr. Sci. Aero.*, 11 *pp.* (*Jan.*, 1949) *In Italian.*

It is possible to calculate flow in air at Mach numbers above unity from the corresponding flow in water. This was done in a number of cases and an experimental check of the flow in both air and water was made; the experiments on the flow in air were performed at Guidonia, and those on the flow in water were performed in Rome. (Bibl. 9).

INDEX AERONAUTICU

532.511 : 530.16

7764. The statistical mechanical theory of transport processes. IV. The equations of hydrodynamics. J. H. IRVING AND J. G. KIRKWOOD. *J. Chem. Phys.*, **18**, 817–29 (*June*, 1950).

The equations of hydrodynamics—continuity equation, equation of motion, and equation of energy transport—are derived by means of the classical statistical mechanics. Thereby, expressions are obtained for the stress tensor and heat current density in terms of molecular variables. In addition to the familiar terms occurring in the kinetic theory of gases, there are terms depending upon intermolecular force. The contributions of intermolecular force to the stress tensor and heat current density are expressed respectively, as quadratures of the density and current density in the configuration space of a pair of molecules. AA

532.51

7765. Analytical structure of the new mechanics of viscous liquids. G. VIGUIER. *Rev. Sci., Paris*, **87**, 86–8 (*April–June*, 1949) *In French.*

An extension of previous work on the mechanics of viscous liquids [Abstr. 2217 (1950)]. By considering first the case of an ideal liquid in which each particle has complete freedom of movement, it is shown how the general equations of motion for a viscous liquid may be derived. T. C. TOYE

532.528

7766. Free boundaries and jets in the theory of cavitation. D. GILBARG AND J. SERRIN. *J. Math. Phys.*, **29**, 1–12 (*April*, 1950).

The formation of a finite cavity behind an obstacle in a uniform two-dimensional stream of ideal incompressible fluid is discussed. A backward jet of fluid, extending from the rear of the cavity into its interior, is shown to be a mathematical necessity. The flow problem is solved in explicit form for an inclined flat plate and for a wedge, and the method applies to a general polygonal obstacle. The flow problem for a curved obstacle is reduced to a non-linear boundary-value problem for an analytic function.

J. G. OLDROYD

532.528

7767. Accelerated-cavitation research. W. J. RHEINGANS. *Trans. Amer. Soc. Mech. Engrs*, **72**, 705–24 (*July*, 1950).

The cavitation-pitting tests described in this paper were made with an accelerated-cavitation machine of the vibratory type. An attempt was made to solve some of the phenomena of cavitation by varying the amplitude of vibration, by varying the depth of submergence of the test specimen in the test liquid, and by using alkalis, acids and oils for the test liquid. Other tests were made to determine the relative resistance to pitting of recently developed materials and techniques for applying these materials. Results showed that accelerated-cavitation tests can be used to determine some of the mechanics of cavitation, as well as to indicate that some of the newly developed materials might be suitable for use on hydraulic

machinery under operating conditions where cavitation occurs. A.

532.591

7768. Water waves over a sloping bottom. E. ISAACSON. *Commun. Pure Appl. Math.*, **3**, 11–31 (*March*, 1950).

The solution to the 2-dimensional problem of progressive gravity waves over a sloping bottom is obtained; assuming a velocity potential Φ, and boundary conditions, $\partial\Phi/\partial n = 0$ at the bottom, $\partial\Phi/\partial y = \partial^2\Phi/\partial t^2$ at the free surface, obtained by neglecting quadratic terms in Bernouilli's equation and in the kinematic surface condition, Φ to approach asymptotically the regular progressive wave solution at infinity. J. E. CAFFYN

532.593

7769. Experimental study of surface waves in shoaling water. R. L. WIEGEL. *Trans. Amer. Geophys. Un.*, **31**, 377–85 (*June*, 1950).

A series of experiments was performed to compare actual wave dimensions with those given by theory for waves moving over a sloping beach. The primary consideration was the change of the water surface elevation at a point with time. It was found that this "profile" corresponded with Rayleigh's extension of the theory of waves to shoal water conditions, except probably in the case of rapidly shoaling water (slopes steeper than 1 : 10) and near the breaker zone. A.

532.595

7770. The damping of small oscillations of a heavy, viscous liquid in a U-tube. C. CLARION. *C.R. Acad. Sci., Paris*, **230**, 1926–8 (*May* 31, 1950) *In French.*

Experimental results relating to the damping of the oscillations of liquids of kinematic viscosities ranging from 0·00118 to 0·095 are in perfect agreement with deductions from the theory of J. Valensi [*C.R. Acad. Sci., Paris*, **224**, 446, 532, 893 (1947)] for both small and large values of the parameter, $R^2\omega p/\nu$, employed by Valensi in his theory. The present results eliminate contradictory results obtained by Christopherson, Gemant, Hogg and Southwell [*Proc. Roy. Soc.*, **168**, 351 (1938)], and by de Karman and Valensi [Abstr. 91 (1949)] and supplement the work of Meuneret. J. S. G. THOMAS

532.595

7771. On two regimes of oscillations of a heavy viscous liquid in a U-tube. J. VALENSI, C. CLARION AND F. ZERNER. *C.R. Acad. Sci., Paris*, **230**, 2002–4 (*June* 5, 1950) *In French.*

These are observed for the damping of the oscillations and correspond to a parabolic velocity distribution across the tube (*a*) with a max. at the centre, (*b*) with 2 max. The decay is expressed as a function of a dimensionless parameter ($R^2\omega p/\nu$). The damping is dependent on amplitude above $R^2\omega p/\nu = 70$ and experiment suggests that this is due to a higher harmonic causing eddies. J. E. CAFFYN

532.595

7772. A dimensionless variable governing the small free oscillations of a heavy viscous liquid in a U-tube. F. ZERNER. *C.R. Acad. Sci., Paris*, **231**, 110–12 (*July* 10, 1950) *In French.*

A solution of the Navier–Stokes equations is given for the harmonic oscillations of a liquid in a tube of circular or rectangular section from which is obtained a dimensionless variable, being a generalization of that proposed by Valensi [*C.R. Acad. Sci., Paris*, **224**, 893 (1947)]. J. E. CAFFYN

532.595

7773. Attenuation of oscillatory pressures in instrument lines. A. S. IBERALL. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 85–108 (*July*, 1950).

A theoretical investigation has been made of the attenuation and lag of an oscillatory pressure variation applied to one end of a tube, when the other end is connected to a pressure-sensitive element. An elementary theory based on incompressible viscous-fluid flow is first developed. The elementary solution is then modified to take into account compressibility; finite pressure amplitudes; appreciable fluid acceleration; and finite length of tubing (end effects). Account is taken of heat transfer into the tube. The complete theory is derived, but the results are summarized in 8 graphs in a form convenient for use in computing. A.

CAPILLARITY 532.6

532.612

7774. Remarks on the surface tension of small droplets. F. P. BUFF AND J. G. KIRKWOOD. Letter in *J. Chem. Phys.*, **18**, 991–2 (*July*, 1950).

532.612 : 536.49

7775. On the temperature coefficient of the surface tension of binary liquid systems. B. YA. TEÏTELBAUM. *Dokl. Akad. Nauk, SSSR*, **71** (*No.* 4) 705–8 (1950) *In Russian.*

In a binary liquid system the value of the temperature coefficient of surface tension is determined by 2 factors: (*a*) the surface activity of one of the components with regard to the other (adsorption), which varies with temperature, and (*b*) a magnitude analogous to the entropy of mixing of solutions, but referred to a unit of surface. The effect of adsorption is important when the surface activity has a high value and varies considerably with temperature. It is demonstrated that, in a binary system endowed with a high surface activity, the surface-tension-temperature-coefficient/concentration curve must pass through a minimum. Surface solutions with positive deviations from ideal solutions (decrease of temperature yielding finally the separation of layers in the surface layer) must have negative values of the surface entropy of mixing (passing through a minimum). On the other hand, in systems where interaction between the components can be observed in the surface layer, the latter values should be positive (passing through a maximum). It is suggested that the temperature coefficient should be plotted against the chemical composition of the surface layer. Such curves reveal the hydration occurring in the solutions of surface-active substances. F. LACHMAN

532.612.4

7776. The capillary rise, contact angle and surface tension of potassium. L. A. QUARTERMAN AND W. L. PRIMAK. *J. Amer. Chem. Soc.*, **72**, 3035–7 (*July*, 1950).

A sample of pure potassium was prepared and

distilled into a Pyrex glass surface tension apparatus that was baked out in high vacuum and potassium vapour. It was found that the potassium wetted the glass with a small contact angle and exhibited a capillary rise which would have required a surface tension of 86 dynes/cm if the contact angle were zero. On standing the glass surface altered, causing the contact angle to increase. Contact angles were measured by two methods. It was shown that the contact angle must have been $< 26°$ at the time of the original measurements. Hence, the contact angle correction to the above result must be $< 11\%$. A.

532.613.4

7777. The measurement of rates of spread. W. G. Burgers, D. H. Greup and A. E. Korvezee. *Rec. Trav. Chim. Pays-Bas.*, **69**, 921–34 (*July–Aug.*, 1950).

A description is given of an apparatus for the measurement of the rate of spread under free expansion of liquid fatty acids and similar substances on water surfaces. Preliminary measurements on valeric, caproic, heptylic, caprylic and nonylic acid with varying degree of acidity of the water indicate that there is an essential difference between valeric and caproic acid on the one hand and heptylic, caprylic and nonylic acid on the other in the manner of spreading of the drop placed on the water surface. Reproducible values are obtained only with the two first mentioned acids. With all the acids a new impulse seems to occur during spreading which increases the velocity of displacement of the film boundary. The values obtained for valeric and caproic acid appear to be mostly independent of the degree of acidity. The course of the displacement of the film boundary can be represented in case of both acids by the same formula which takes into account the transition from a close-packed film into a less closely packed film. A.

532.64

7778. The limited applicability of the Neumann law to the limiting angles of wetting. Ya. B. Aron and Ya. I. Frenkel. *J. Exp. Theor. Phys., USSR*, **20**, 453–7 (*May*, 1950) *In Russian.*

For good as well as for bad wetting the limiting angles of wetting depend on the slope of the surface and on weight (dimensions) of the droplets (bubbles). The "right" angle (advancing) increases, the "left" angle (receding) decreases, with increasing slope. Even in a horizontal plane the limiting angles of wetting depend on droplet weight. These facts and also the invariance of the values of the limiting angles for hard metals in the presence of an electric potential difference and the behaviour of drops on the separation face of two solid phases contradict Neumann's law. The latter thus appears as an approximation, admissible only under certain conditions. Yarnold and Mason's [Abstr. 1726 (1949)] attempt to find the actual equation of the wetting angle could not yield a positive result, because statical friction forces on the wetting perimeter, the influence of the droplet mass and the angle of slope of the surface on the wetting angle must all be considered; this leads to different values for the advancing and receding angle. B. F. KRAUS

532.64 : 539.2

7779. Surface roughness and contact angle. J. Bikerman. *J. Phys. Coll. Chem.*, **54**, 653–8 (*Ma* 1950).

The contact angles formed by water drops stainless steel plates of varying degrees of roughn were measured in an attempt to find a relati between surface roughness and contact angle. Bc rolled and polished sheets were used, the surfa roughness being measured by means of a styl instrument. The fact that no relation was found attributed to the fact that a rough surface is a mixtu of ridges, which obstruct melting, and grooves, whi enhance it. See also Abstr. 1517 (1950).

T. C. TO

MOLECULAR THEORY OF LIQUIDS 532

532.7 : 536.423.

7780. A theoretical basis for the Antoine vap pressure equation. F. Gutmann and L. M. Simmon *J. Chem. Phys.*, **18**, 696–8 (*May*, 1950).

The Antoine vapour pressure equation $\log p = A - B/(t + C)$ is theoretically derived from van d Waals' equation and the energy of an assembly Einstein oscillators. The values of the Antoi parameter C are shown to be related to the characte istic frequency of the liquid. The values of th parameter obtained from vapour pressure data a shown to agree with those calculated from viscosit and from the velocity of propagation of sound. A

532.7 : 536.71 : 530.16

7781. Remarks on the calculation of the thermo dynamic pressure in quantum statistics. J. Horowitz *J. Phys. Radium*, **11**, 241–3 (*May*, 1950) *In French.*

The problem of whether or not the pressure of fluid according to thermodynamics (or statistica mechanics) is equal to the pressure according t quantum hydrodynamics is discussed. The con clusion arrived at by Green and by de Boer [Abstr 1551–2 (1950)] that they are not, is attributed t insufficient care having been given to the effect o the operators involved of a passage from a syste occupying an infinite volume to one occupying a finit volume. The author's view is that the two pressure should be identical. P. T. LANDSBERG

532.72 : 535.41

7782. Tests of flowing junction diffusion cells with interference methods. L. G. Longsworth. *Rev. Sci. Instrum.*, **21**, 524–8 (*June*, 1950).

The construction and manipulation of two diffusion cells, one of glass and the other of stainless steel, are described. In both cells the initially sharp boundary is formed by allowing solution and solvent to flow together into a narrow horizontal exit slit in the side wall of the diffusion channel. These cells have been tested by diffusion measurements with the aid of the Gouy interference method. Moreover, in the case of the metal cell which is provided with a reference channel in close proximity to that in which diffusion occurs, an interference method that gives the re-

ractive index directly as a function of the height has lso been studied. A.

532.74 : 534.321.9 : 534.21

Ultrasonic absorption in mixtures of unassociated nd associated liquids. *See Abstr.* 7811

MECHANICS OF GASES 533

533.15.096

7783. A modification of the theory of the thermal diffusion column. H. G. DRICKAMER, E. W. MELLOW AND L. H. TUNG. *J. Chem. Phys.*, **18**, 945–9 (*July*, 1950).

Thermal diffusion measurements were made for the system A–Ne over a pressure range from 4–108 atmospheres. It is found that the classical theory of Furry, Jones and Onsager is inadequate to describe the results obtained on a series of carefully constructed thermal diffusion columns. A modification of their theory, based on a more complete picture of the behaviour of the column, is developed which fits the data satisfactorily. It is predicted and confirmed by experiment that even though turbulence occurs over part of the gap, a separation will occur, and may even be enhanced by this turbulence. A.

533.15.096

7784. Thermal diffusion in the critical region. I. N. C. PIERCE, R. B. DUFFIELD AND H. G. DRICKAMER. *J. Chem. Phys.*, **18**, 950–2 (*July*, 1950).

Thermal diffusion data in the critical region have been obtained for the system C_2H_6–Xe using very low Xe concentrations and Xe^{133} as a tracer. The results indicate that even at pressures as low as 4 atmospheres and temperatures 20° above the critical, the simple kinetic theory of gases is not adequate to explain thermal diffusion. In the critical region evidence is found for the existence of clusters of C_2H_6. A.

533.15.096

7785. Thermal diffusion in the critical region. II. E. B. GILLER, R. B. DUFFIELD AND H. G. DRICKAMER. *J. Chem. Phys.*, **18**, 1027–30 (*Aug.*, 1950).

The previous measurements [preceding Abstr.] on thermal diffusion in the critical region for the system ethane–xenon are extended and completed, with the use of a modified radioactive tracer technique. A rough calculation of cluster size in the critical region is made. A mechanism of molecular motion in the dense gas above the critical point, consistent with the data is present. It is shown that the transformation between dense gas and liquid occurs without discontinuity as far as thermal diffusion is concerned. The thermal diffusion columns operated in the region of turbulent heat transfer gave a separation as predicted by the modified theory of the column. A.

533.15.096

7786. Thermal diffusion in the system methane–xenon. L. H. TUNG AND H. G. DRICKAMER. *J. Chem. Phys.*, **18**, 1031 (*Aug.*, 1950).

Measurements have been carried out at a temperature 100°C above the critical using two thermal diffusion columns. The results confirm the column theory presented earlier [preceding Abstr.], and are consistent with the results obtained on the system ethane–xenon. A.

533.5

7787. An effective vacuum cut-off. G. W. SEARS AND E. R. HOPKE. Note in *Rev. Sci. Instrum.*, **21**, 570 (*June*, 1950).

533.5

7788. A low-impedance high-vacuum valve. R. I. GARROD. Note in *J. Sci. Instrum.*, **27**, 205 (*July*, 1950).

533.5 : 531.787

7789. A note on the absolute manometer. R. W. ASMUSSEN AND B. BUCHMANN-OLSEN. *Trans. Danish Acad. Tech. Sci.* (*No.* 6) 8 *pp.* (1948).

A Knudsen absolute manometer modified according to S. Werner [*Z. tech. Phys.*, **20**, 13–16 (1939)] was constructed and is recommended for its simplicity and robustness. Calibration curves obtained were found to vary from the simple calibration stated by Werner, especially at higher pressures when calibration depends on temperature of gauge tanks and on ambient temperature. G. WITTENBERG

533.5 : 531.788.12

7790. A rotary McLeod gauge. M. AXELBANK. *Rev. Sci. Instrum.*, **21**, 511–13 (*June*, 1950).

The use of the sensitive McLeod gauge is limited by its fragility, bulk and lack of portability. A new type of McLeod gauge is described which greatly reduces these difficulties. A helix of several turns of glass tubing provides the volume through which the gas is compressed by a small quantity of Hg as the gauge is rotated upon its rotary seal. A model has been constructed which is $16 \times 16 \times 21$ cm in over-all dimensions and weighs less than 1 kg. Its gauge constant with a 0·8 mm capillary is $1{\cdot}4 \times 10^{-6}$ mm^{-1}. A.

533.5 : 531.788.7

7791. A Philips-type ionization gauge for measuring of vacuum from 10^{-7} to 10^{-1} mm of mercury. E. C. EVANS AND K. E. BURMASTER. *Proc. Inst. Radio Engrs*, **38**, 651–4 (*June*, 1950).

Construction and operation details of the gauge are given in addition to its advantages and disadvantages as compared to hot-cathode-type ionization gauges. A.

533.5 : 531.788.7

7792. Extension of the low pressure range of the ionization gauge. R. T. BAYARD AND D. ALPERT. Note in *Rev. Sci. Instrum.*, **21**, 571–2 (*June*, 1950).

533.5 : 531.788.7 : 621.317.39

7793. A universal power supply circuit for use with ionization gauges. J. W. A. VAN DER SCHEER. *P.T.T.-Bedrijf*, **3**, 24–9 (*May*, 1950) *In Dutch.*

The uses of ionization gauges are briefly discussed. The necessary requirements which the power supply and indicating circuits have to meet are defined, and a circuit satisfying these requirements is fully described. Particular attention is paid to the design of the current generator and stabilizer, microammeter circuit and automatic cut-out circuit.

E. P. WOHLFARTH

533.5 : 621.316.7.078

7794. Automatic control of high-vacuum systems. J. W. Clark and G. H. Witts. *Electronics*, **23**, 108–10 (*June*, 1950).

The equipment is accessory to an ionization gauge operating between 6×10^{-8} and 10^{-2} mm of Hg. It consists of a control and indicator unit. The control unit comprises regulated power supplies, meters and switches for the gauge, etc. The indicator unit contains a 4-stage carrier-type amplifier incorporating a 60 c/s vibrating reed. The amplifier output is rectified by a second vibrator in synchronism with the first and provides up to 10 mA d.c. in a 500 Ω load. The output meter has a log scale marked 1 to 10 and gives approx. constant percentage accuracy regardless of pointer position. Scale multiplication is effected by a motor-driven rotary switch. This switch is actuated by a double-triode fed from the amplifier output and is provided with scale-changing relays in the anode circuits to maintain the meter reading between 6 and 100% of full-scale deflection. The rotary switch operates range-indicating lights on the panel and, if required, others on remote panels. Auxiliary contacts are provided for automatic process control. H. G. M. SPRATT

533.6.011.5

7795. On the attached shock wave when the downstream velocity at the point of the obstacle is subsonic. H. Cabannes. *C.R. Acad. Sci., Paris*, **230**, 1830–2 (*May* 22, 1950) *In French.*

A theoretical investigation of the flow of a compressible fluid around a pointed axially-symmetrical obstacle. An earlier treatment [*C.R. Acad. Sci., Paris*, **229**, 923–5 (1949)] is valid only when the Mach no. M of the incident flow $> M_r(\psi)$ where ψ is the semi-angle of the vertex of the obstacle and r is an integer representing the order of the lowest non-zero derivative of the apex curvature of the obstacle. In the present paper the range of validity is extended to $M < M_r(\psi)$ by introducing a non-analytic term into the equation defining the shape of the shock wave. A parameter m occurring in this term corresponds with the parameter r in the earlier solution; whereas r was necessarily integral, m is not restricted in this way. For integral values of m the treatment gives results agreeing with the earlier one, but the new set of solutions for non-integral m extends the range of validity to $M < M_r(\psi)$ in which case the gas-velocity at the apex of the obstacle is subsonic.

A. SCHOFIELD

533.6.011.5

7796. A note on Prandtl's formula for the wavelength of a supersonic gas jet. D. C. Pack. *Quart. J. Mech. Appl. Math.*, **3**, 173–81 (*June*, 1950).

For small fluctuations of a uniform supersonic gas jet about the state in which it enters a medium with zero excess-pressure it is possible to express the "wavelength" in terms of the mean velocity of the jet. The mean velocity is that of the bounding stream-lines and not the velocity of efflux as assumed by Prandtl in an earlier investigation. With this correction, better agreement is obtained between theoretical and experimental values for the wavelength of cylindrical jets. It is shown that the approximate theory may be expected to have a wider range of application to jets with axial symmetry than to plane jets, and to forecast wavelengths for pressure ratios outside the range for which it may be applied to give conditions inside a jet.

533.6.0

7797. Optical bench for investigations in supersonic flow at Bellevue. E. Brun, H. Gondet and M. Plan. *J. Rech. Cent. Nat. Rech. Sci.* (*No.* 1) 107–11 (1950) *In French.*

The strioscopic system described comprises essentially a controlled arc source of light and a double field lens (dia. 21 cm, focal length 1·5 m) producing an image which is shielded from the light source by a screen having almost the same dimensions as the image. A projection objective is used to obtain an image of the surface to be studied on a screen between the field lens and the primary image. Any optical disturbance in the system is shown by a deviation of the luminous ray, which produces a luminous spot or striation on the screen. Cinematographic records are obtainable. The method may be used to show small variations in the d and refractive index of the medium, and to demonstrate interferometer effects this is not possible by the shadow method. Photographs demonstrate the results obtainable, in comparison with those of the shadow method.

J. GRAN

MOLECULAR THEORY OF GASES 533.7

533.7.0

7798. Demonstration of the measurement of thermal molecular velocities with an analytical balance. H. Bucka and U. v. Haselberg. *Naturwissenschaften*, **37** (*No.* 8) 183 (*April*, 1950) *In German.*

The weight of a vessel of evaporating liquid is in error due to the back-pressure of escaping molecules. A short succession of readings of the pointer of a heavily damped balance, while evaporation is taking place and after it has stopped, enables this back pressure to be measured. G. J. KYNCH

VIBRATIONS . ACOUSTICS 534

534.1

7799. On one-term approximations of forced non-harmonic vibrations. G. Schwesinger. *J. Appl. Mech.*, **17**, 202–8 (*June*, 1950).

Steady forced vibrations of harmonically excited nonlinear systems deviate from a sinusoidal wave-form, the magnitude of the deviation depending upon the frequency of the exciting force and the nature of the system concerned. Approximations by simple harmonic solutions suggested so far are either restricted to special vibration problems or generally fail to provide the desired accuracy without giving account of the errors committed. An improved general method is proposed and demonstrated,

lding the best accuracy attainable with harmonic utions. This method, furthermore, gives the proximate root mean square of the error and thus ows for establishing dependable limits for its plicability. A.

534.13 : 534.17

00. Influence of the relative radial thickness of a g on its natural frequencies. F. BUCKENS. *Acoust. Soc. Amer.*, **22**, 437–43 (*July*, 1950).

The flexural vibrations of a ring in its plane are udied by taking shear effect into account, and it is oposed to compute the deviation from the classical quency formula, which is only valid for very small tios of the thickness to the diameter. The possibility extension is included, and in this procedure the quencies of extensional vibrations are obtained as by-product. It is seen that the shear effect plays a edominant role in the deviation from the classical rmula, and is more important than curvature effects d the rotational inertia. Extensibility influence is und to be very small. An interesting comparison n be made with the similar influence of secondary ctors on the flexural vibration's frequencies of a raight beam. A.

534.141.4 : 621.396.611.1

801. Strouhal's relation between wind speed and tch of the sound produced by friction—a general law physics. J. ZAHRADNÍCEK AND F. KOZUMPLÍK. *as. Pèst. Mat. Fis.*, **75** (*No.* 2) 97–102 (1950) *In zech.*

There is a complete analogy between the phenomena f the Barkhausen-Kurz oscillations in electron ibes, the Zacek oscillations of magnetrons [*Z. ochfrequenztech.*, **32**, 172 (1928)], those investigated y Sahanek in a diode designed for the purpose *Phys. Z.*, **29**, 640 (1928)] and phenomena for which trouhal found in 1878 a relation $ND = ku$ when udying the friction sounds excited by wind in taut ires (N frequency, D diameter of the wire, u wind peed). It is shown that this relation is a general law f physics which is valid for liquid and gas particles itting an obstacle as well as for electrons in a triode ith a positive grid, in a magnetron or in a diode with n external cathode, the internal anode of which is the form of a wire. B. F. KRAUS

534.151

802. Accelerometer calibration technique. F. G. YZZER AND H. C. HARDY. *J. Acoust. Soc. Amer.*, 2, 454–7 (*July*, 1950).

A technique is described for the dynamic calibration of accelerometers or other vibration-measuring nstruments. For each calibration frequency the ccelerometer is attached to a free-free bar driven lectromagnetically at a known sinusoidal displacement. Displacement amplitudes are measured by neans of strain gauges which are calibrated optically. The accelerometer output can be conveniently compared in magnitude and phase with the displacement as indicated by the strain-gauge voltage. Instruments ave been calibrated at frequencies between 400 and 2 000 c/s. The error in determining phase angle was bout $\pm 2°$. The error in the optical measurement f displacement was about $\pm 0{\cdot}1 \times 10^{-3}$ cm. The er cent error, however, could be made fairly small by calibrating the strain gauges at large displacements of the bar. For instance, the error in calibrating a 200 g accelerometer at 1 000 c/s was about $\pm 2\%$. A.

534.152

7803. Visual observation of the vibratory phenomena in a sounding [organ] pipe. C. CHARTIER, J. BOUROT AND J. NOËL. *C.R. Acad. Sci., Paris*, **230**, 2269–70 (*June* 26, 1950) *In French.*

A brief description is given of experiments to make visible and to measure the amplitude of vibration of air in a resonating tube. The best results are obtained using very fine powder (e.g. Al powder) and very low frequencies. In the experiments described an open tube of length about 6 metres vibrating at a frequency of 32 c/s was used. The amplitude of the Al particles at points of maximum displacement attained 1 cm for a blowing pressure of 80 cm of water. The error in amplitude measurement, due to the mass of the Al particles, was estimated to be less than 1 mm. The vibrating particles were photographed (*a*) using intermittent illumination, and (*b*) with a rotating mirror to demonstrate the sinusoidal oscillation of the particles. A. B. WOOD

534.21

7804. The sound waves generated by a particle at supersonic speed. M. H. MARTIN AND G. B. JACKSON. *Schweiz. Arch. angew. Wiss. Tech.*, **16**, 114–19 (*April*, 1950).

The manner in which the sound wave moves through space as the particle moves along its path is considered first for the case of a particle moving at constant speed along a horizontal straight line. The general problem for a particle moving along a curvilinear path with non-constant speed is examined—the wave front being shown to be convex for the decelerating particle and concave for the accelerating particle. The particular problem of a particle moving under the action of gravity and air-resistance only, is considered for cases where the limiting velocity is sub- and super-sonic. The assumptions made are briefly reviewed. G. F. HODSMAN

534.21

7805. Experiments on acoustic absorption in sand and soil. W. L. NYBORG, I. RUDNICK AND H. K. SCHILLING. *J. Acoust. Soc. Amer.*, **22**, 422–5 (*July*, 1950).

The acoustic absorption of sand and soil with varying amounts of water (dry to saturated) has been investigated in the 10 to 100 kc/s range by two methods. In one, the source and a number of equally spaced probe microphones were imbedded in the medium. In the other the source and receiver were in air and the transmission loss was obtained for samples of varying thickness. The unsaturated media were found to have attenuation coefficients ranging from 2 db/cm for nodulous, loose soils to greater than 25 db/cm for finely divided soils and sand, the value for any particular sample depending in an important way on its flow resistance. In water-saturated media the attenuation was found to depend markedly on the amount of gas present in the mixture. Air-free mixtures prepared in an evacuated chamber had attenuation coefficients which were too small to

be measurable—probably less than 2 db/cm. On the other hand, for mixtures prepared in the presence of air the attenuation coefficients immediately after mixing were extremely large. For one sample the range was from 26 db/cm at 10 kc/s to 64 db/cm at 30 kc/s. When a source and microphone, separated by a distance of 1 cm, were immersed in such a freshly stirred mixture and then left undisturbed, the intensity level increased in time—as much as 50 db at 30 kc/s over a period of 100 hr. A.

534.21

7806. On the absorption of high power sound waves. Y. TAKESADA. Letter in *J. Acoust. Soc. Amer.*, **22,** 515–16 (*July*, 1950).

534.21 : 512.99

7807. Note on "The application of vector analysis to the wave equation." R. V. L. HARTLEY. Letter in *J. Acoust. Soc. Amer.*, **22,** 511 (*July*, 1950).
See Abstr. 2979 (1950).

534.21 : 532.516

7808. Classical viscosity in tubes and cavities of large dimensions. B. P. BOGERT. *J. Acoust. Soc. Amer.*, **22,** 432–7 (*July*, 1950).

A method for the calculation of viscous losses in acoustic waveguides and cavities is described, similar to that used for electromagnetic waves. The loss in a plane wave in a round tube is discussed and the results agree with those previously obtained by others. The attenuation for two higher modes in hard wall guides is computed, as well as the decay constants for a cylindrical cavity for longitudinal and pure radial modes. A.

534.21 : 534.321.9

7809. Theory of ultrasonic absorption in fluids. A. GIERER AND K. WIRTZ. *Z. Naturforsch.*, **5a,** 270–5 (*May*, 1950) *In German.*

The absorption of sound in liquids is discussed in terms of the theory which assumes that a liquid has a quasi-crystalline structure. The theoretical relationships are compared with those determined experimentally for a number of liquids at frequencies of about 10 Mc/s. H. J. H. STARKS

534.21 : 534.321.9

7810. Anomalies in the propagation of ultrasonics in metals in relation to their structure. E. DE KERVERSAU, J. BLETON AND P. BASTIEN. *Rev. Métall.*, **47,** 421–46 (*June*, 1950) *In French.*

Under certain conditions, anomalies are observed in the transmission and reflection of ultrasonic waves in metals; in the case of reflection, these appear as parasitic echoes. A simple theoretical treatment attributes the anomalies to differences in the properties between the grain boundaries and the matrix. An attempt is then made to verify the theory by observations of the transmission and reflection properties, using a 2·5 Mc/s source, of eutectoid structures in C steel and of Ni–Cr–Mo steels. Photomicrographs of the materials tested are included and the importance of the dimensions of the α- and γ-phase constituents, relative to the wavelength of the source, is shown. The use of a microscope employing polarized light in studying the α-structure in steels is described. H. J. H. STARKS

534.21 : 534.321.9 : 532

7811. Ultrasonic absorption in some mixtures of unassociated and an associated liquid. D. SET Letter in *Nature, Lond.*, **166,** 114 (*July* 15, 1950).

534.213 : 538.566.2 : 537.

Magneto-hydrodynamic waves in a plasma. *Abstr.* 8016–17

534

7812. Dispersion of the velocity of sound in ammon I. ÖZDOĞAN. *Istanbul Univ. Fen. Fak. Mec. Ser.* **15,** 163–78 (*April*, 1950) *In French.*

The construction of an acoustic interferometer described and the quartz frequency is determin from the known velocity of sound in CO_2-free, air to an accuracy of 0·5–0·1%. With NH_3 gas velocity depends on the pressure after making correction, based on van der Waals' equation, departure from a perfect gas. Kneser's theo [*Ann. Phys., Lpz.*, **11,** 761–76 (*Nov.* 10, 1931), et is applied to the results. J. E. CAFF

534.22 : 534.32

7813. Ultrasonic velocity dispersion in solid roo T. F. HUETER. Letter in *J. Acoust. Soc. Amer.*, 514–15 (*July*, 1950).

534.222

7814. On the thickness of plane [shock] waves in gas in turbulent motion. A. SAKURAI. *J. Phys. So Japan*, **5,** 114–17 (*March–April*, 1950).

Theoretical. In the absence of thermal conductio radiation and viscosity, the region of transition pressure, density and velocity in a plane shock infinitely thin, but if the effects of such processes energy transfer and dissipation are allowed for, th transition region becomes finite in thickness. It shown that turbulence provides a mechanism energy transfer and dissipation whereby a pla disturbance of finite thickness and of a permanen type as regards its mean properties can be propagate in a compressible fluid. The thickness of the trans tion zone is $LmM/(M^2 - 1)$ where L is the mixin length and m, M are the Mach nos. of the veloci perturbations and of the main flow. A. SCHOFIEL

534.231

7815. Sound scattering from a fluid sphere. V. C ANDERSON. *J. Acoust. Soc. Amer.*, **22,** 426–31 (*Jul* 1950).

The scattering of sound from a spherical flui obstacle of size comparable to a wavelength is con sidered, neglecting dissipation. Calculations of th acoustic pressure and the total energy in the scattere wave are presented graphically; sound velocities an densities of the sphere lie between 0·5 and 2·0 time that of the external medium. The limiting cases o Rayleigh scattering and scattering from a fixed rigi sphere are also shown for comparison. In the regio where the diameter of the sphere is comparable to wavelength, the scattering is a complicated function o frequency, showing in some cases large maxima an minima. The amplitude of the scattered wave in th backward direction from a fluid sphere a few wave lengths in diameter exceeds twice that from a rigi sphere of the same size for the case of the soun velocity 0·8 and density equal to that of the surround ing medium. A

534.232 : 534.321.9 : 621.395.614

16. **Crystal microphone for use in water.** W. ITTNER. *Z. angew. Phys.*, **2** (*No.* 5) 206–10 (1950) *German.*

The theory, construction and response curve of a chelle salt ultrasonic pick-up are described.

H. J. H. STARKS

534.232 : 538.652

17. **The relative output from magnetostriction rasonic generators.** F. M. LESLIE. *J. Acoust. Soc. ner.*, **22**, 418–21 (*July*, 1950).

An approximate theoretical treatment of the output m the simplest type of ultrasonic generator in the m of a laminated bar is first developed. The mbbell generator is shown to be very similar to the nple bar type and the previously obtained relations e then employed for determining the relative output terms of its face and neck dimensions. A.

534.232 : 538.652 : 621.318.3 : 538.221

Evaluation of the magnetostrictive properties of iperco. *See Abstr.* 8144

534.232 : 621.395.623.7

18. **Electroacoustic phase shift in loudspeakers.** . A. EWASKIO AND O. K. MAWARDI. *J. Acoust. c. Amer.*, **22**, 444–8 (*July*, 1950).

Direct measurements of envelope delay have been btained for a series of commercial and experimental udspeakers. The modulation phase shift method of yquist and Brand has been adapted for direct dication of envelope delay by utilizing an electronic ase meter. A continuous record of the delay is btained by an automatic level recorder suitably con- ected to the phase-meter. Pressure-amplitude curves easured under the same conditions provide data for preliminary attempt to interpret the correlation etween delay response and pressure response. A.

534.321.3

19. **The scale of Iranian music.** M. BARKÉCHLI. *nn. Télécommun.*, **5**, 195–203 (*May*, 1950) *In French.*

The controversial question of the relation between ne oriental scale (typified by the Persian scale) and ne Pythagorean scale is discussed. The evolution f the Iranian musical scale is traced. Cathode-ray scillograph records have been made of Iranian nusic to verify the author's views. A. B. WOOD

534.321.3

20. **Measurement of the harmonic intervals in the musical] scale by the method of subjective consonances.** M. BARKÉCHLI. *C.R. Acad. Sci., Paris*, **231**, 42–3 (*July* 3, 1950) *In French.*

Oscillographic measurements are made of the armonic intervals using an electrostatic pickup on violin. The results obtained confirm those of Corau and Mercadier relative to the existence of two cales, one melodic and the other harmonic.

A. B. WOOD

534.321.9 : 534.614

21. **Ultrasonic measurement techniques applicable o small solid specimens.** H. J. MCSKIMIN. *J. Acoust. oc. Amer.*, **22**, 413–18 (*July*, 1950).

Phase comparison at high ultrasonic frequencies found to be particularly suited to velocity of ropagation measurements (and hence measurement f elastic constants) for small solid specimens such as ngle crystals. Both longitudinal and transverse waves may be used, with accurate results possible even when the specimen loss becomes high. A pulse technique is used which allows exact determination of the number of wavelengths in the acoustic path, and a direct measurement of phase shift at reflecting interfaces. The use of $\lambda/4$ plastic coupling seals to minimize errors is explained; necessary theoretical analysis is included. Illustrative data for fused silica and single crystal germanium are given. A.

534.373

7822. **Attenuation of (1,0) "transverse" acoustic waves in a rectangular tube.** E. A. G. SHAW. Letter in *J. Acoust. Soc. Amer.*, **22**, 512–13 (*July*, 1950).

534.441.2 : 621.392.52

7823. **A continuously variable filter.** C. G. M. FANT. *J. Acoust. Soc. Amer.*, **22**, 449–53 (*July*, 1950).

A heterodyne filter for the speech frequency range is described. It can be used as a band-pass filter of continuously variable l.f. and h.f. cut-offs adaptable for any desired transmission band in the frequency range 40–4 000 c/s and with more than 60 db attenuation and with cut-offs of a maximal slope of 1 db per c/s. Band-width and l.f. cut-off are varied by 2 separate controls. Band elimination filtering can also be obtained with continuously variable mid-frequency but with band-width restricted to either 300 or 800 c/s. The variable filtering is performed by single side-band transmission with successive filtering in 2 modulation units and demodulation in a 3rd unit. Distortion products from impurities in transmission and modulation are kept at a −60 db level and random noise at a −85 db level, relative to a single test tone. The filter was designed for articulation tests and general speech research purposes and also as a wave analyser of continuously variable band-width, 45–4 000 c/s in the frequency range 40–2 000 c/s. The maximum permissible speed in analysis of sustained sounds, governed by the inverse square of band-width law, is discussed with regard to the quality of the analysing band-pass filter. A.

534.522 : 534.321.9 : 535.371

7824. **A new technique for producing acoustic-optical pictures.** H. SCHREIBER AND W. DEGNER. *Ann. Phys., Lpz.*, **7** (*No.* 6) 275–8 (1950) *In German.*

A summary is given of the methods available for obtaining pictures of the passage of an ultrasonic wave, particularly the vibration emerging from the face of a test specimen showing its lack of homogeneity. The new method is based on the fact that some of the phosphides of the sulphide group phosphoresce when absorbing energy in an ultrasonic field, so that the light emitted by such powders depends on the amplitude of the vibration of the particles. Patterns can be obtained showing the distribution of energy across a field, the method being sufficiently sensitive to show the effect of holes 3 to 6 mm dia. in an Al plate tested at 1·07 Mc/s. A. C. WHIFFIN.

534.6 : 621.38

7825. **Background noise and the application of a continuous sound spectrum in acoustics.** P. CHAVASSE AND R. LEHMANN. *Ann. Télécommun.*, **5**, 229–36 (*June*, 1950) *In French.*

The Schottky and the Johnson effect exist simultaneously in electron valves. In gaseous tubes the Schottky effect predominates. With a type 6A7 valve

the total (Schottky + Johnson) effect has a p.d. of 160 μV. In appropriate circuits these effects are made a convenient source of noise the spectrum of which is continuous. Neon tubes are used as noise generators in preference to heptodes (pentagrids). A source is described having a linear spectrum with $\Delta F/F = \text{const.}$ which is an advantage in physiological acoustics since the ear is sensitive to $\Delta F/F$. The spectrum of an artificial male voice is almost identical with the standard spectrum of the average human male voice. The application of the artificial voice in electro-acoustics, architectural acoustics (measurement of reverberation; of the absorption coefficient of materials; of the sound transmission of partition walls) is discussed. In physiological acoustics these generators are of great interest in the measurement of the threshold of hearing. W. SUMMER

534.63

7826. Problem of unambiguous frequency measurement by comparison with a fixed standard. H. M. SCHMIDT. *Z. angew. Phys.*, **2** (*No.* 5) 219–23 (1950) *In German.*

The unknown frequency f_x is mixed with the harmonic spectrum of the standard f_0 in two modulators in one of which the standard is subjected to a phase shift ϕ. The phase shift between the difference frequencies is then $\pm n\phi$ according to whether f_x is greater or less than the nearest harmonic nf_0; and the order number n and the sign of the difference frequency are thus determined. L. ESSEN

534.631

7827. A differential method for measuring the variation of the proper frequency of a cavity. R. LACROIX AND C. RYTER. *Arch. Sci.*, **3** (*No.* 2) 165–9 (1950) *In French.*

The cavity is coupled to a standard one. When the frequencies are equal the resonance curve has two equal peaks. If one of the frequencies varies slightly, a measurement of the amplitudes of the two maxima makes possible a simple evaluation of the frequency difference. L. PINCHERLE

534.75

7828. The effect of a thermal masking noise on the pitch of a pure tone. E. D. SCHUBERT. *J. Acoust. Soc. Amer.*, **22**, 497–9 (*July*, 1950).

When a pure tone and a masking noise are fed into the same ear simultaneously, the pitch of the pure tone is raised. The effect is more pronounced at low loudness levels and is progressively greater as the frequency of the tone rises. Apparently the phenomenon is not present if the pure tone is 20 db or more above its masked threshold. Nineteen graduate music students served as subjects in the experiment. Control measurements were made to estimate the effects of diplacusis and of the difference in intensity between the masked and the unmasked pure tone when they were matched in loudness. A.

534.784

7829. An experimental study of vowel intensities. G. FAIRBANKS, A. S. HOUSE AND E. L. STEVENS. *J. Acoust. Soc. Amer.*, **22**, 457–9 (*July*, 1950).

One hundred and ten monosyllabic words, 10 for each of the 11 common American vowels, were spoken in isolation by each of 10 subjects. Most of the differences between the mean relative intensities of the vowels were found to be statistically significa Among the words for a given vowel the intensity that vowel was found to differ significantly in m instances, a variation tentatively attributed consonantal environment.

534.8

7830. A tentative criterion for the short-te transient response of auditoriums. R. H. BOLT A P. E. DOAK. Letter in *J. Acoust. Soc. Amer.*, 507–9 (*July*, 1950).

Studies of the response of an auditorium to a sh tone burst have indicated that the character of t first 20 or 30 db of sound decay, the "short-ter response, is closely related to the subjective "hearir quality" of the room. Recently Haas has investigat the effect of a single echo on the subjective hearing speech. On the basis of some of Haas' results a other information on the hearing of speech in roon a tentative criterion for the short-term response h been formulated as curves of amplitude *v.* time del of each reflection relative to the direct sound. T criterion correctly rank-orders subjective qual observations reported by others, and agrees quan tatively with some subjective judgments report here.

534.8

7831. Remarks on some problems of room acoustic S. SAWADE. *Elektrotech. Z.* [*ETZ*] **71**, 245–6 (*M* 1950) *In German.*

In the study of room acoustics the author intr duces the conception of "sound-radius" r_H as characteristic of the room (where $r_H = 0{\cdot}057\sqrt{V/T}$ V is volume and T reverberation time of the room Using this device, simple rules are derived for t arrangement of loud-speakers and microphones closed rooms, especially in relation to acoustic bac coupling. It also provides a simple explanation the empirically derived optimum reverberation tim of rooms. A. B. WOO

534.8

7832. The use of three-dimensional models in roo acoustics. R. W. MUNCEY. Letter in *J. Acoust. So Amer.*, **22**, 510–11 (*July*, 1950).

534.861.1 : 621.396.712

7833. Developments in studio design. L. L. BER NEK. *Proc. Inst. Radio Engrs*, **38**, 470–4 (*May*, 1950

Lists the essential design features for a broadca studio, and illustrates the manner in which certai European broadcasting houses have expressed thes features architecturally. The paper covers: Desig criteria; Studio shaping; Control of reverberatio time and diffusion; Reduction of transmitted soun Curves of preferred reverberation times for studio and preferred reverberation time *v.* frequency charac teristics, and means for providing necessary diffusio and absorption of the sound in a room are given.

OPTICS . RADIATION . SPECTRA 535

535.21

7834. The infra-red radiation converter. P. E WEBER. *Optik*, **6** (*No.* 5) 290–2 (1950) *In German.*

A W wire, heated to 2 600°c by d.c. is irradiate

modulated infrared radiation, which alters its nperature, and hence the quantity of radiation nitted. This radiation falls on a Cs photocell whose tput is amplified and can be recorded. The source radiation was a cavity radiator maintained at the mperature of melting Al. One possible development the conversion of infrared to visible light.

N. CORCORAN

535.214.6

35. Photophoresis in indigotin smoke at atmoheric pressure and in sunlight. M. MAITROT. *R. Acad. Sci., Paris*, **230**, 1855–7 (*May* 22, 1950) *French.*

Following the work of Ehrenhaft and Tauzin bstr. 73–4 (1948)], the author has photographed otophoresis tracks with a heliostat and *F*/2 micro-ope objective. The smoke particles rapidly coalesce chains at least 10 μ long but the sense of the tracks es not change. Tracks may be helical, sinusoidal, mniscates or irregular. Frequencies are 1½–100 r sec.

G. F. LOTHIAN

535.222

336. Measurement of the velocity of light using uartz crystals. D. W. R. MCKINLEY. *J. Roy. stron. Soc., Can.*, **44**, 89–103 (*May–June*, 1950).

This paper describes work done in 1937–38 on the easurement of the velocity of light using vibrating uartz crystals directly to modulate the light beam : 8 Mc/s. The value obtained for c was 299 780 ± 0 km/s *in vacuo*, the major portion of the error being ue to inadequate facilities for measuring the distance. f chief significance, however, is the accuracy of etermining the null position, which contributed 0 km/s to the error in c. The technique is inherently apable of yielding a value of c fully comparable with ontemporary determinations.

A.

535.233.5

837. The optical emissivity of titanium and zironium. F. J. BRADSHAW. *Proc. Phys. Soc., Lond. B*, **3**, 573–7 (*Aug.*, 1950).

A method of measuring the optical emissivity of i and Zr using eddy current heating is described. he specimen consisted of a cylinder of metal drilled ith a small black-body hole, and its real and apparent emperatures were measured with an optical pyroeter at a mean wavelength of 0·652 μ. The variaion of emissivity with temperature was investigated nd the precautions taken to avoid errors are escribed.

A.

535.235

838. On the monochromatic emissivity of thorium. G. MESNARD. *C.R. Acad. Sci., Paris*, **230**, 1582–3 (*May* 3, 1950) *In French.*

Gives the results of measurements, at $\lambda = 0{\cdot}65\ \mu$, f the emissivity ($\varepsilon$) of Th, deposited on a W wire as ore. Values of ε vary from 0·4 down to 0·09 epending on the temp. at which observations are ade and on the heat treatment given. Details of hese treatments are given.

J. D. CRAGGS

535.242 : 535.42

839. The influence of diffraction in measurements f stray light. M. FRANÇON AND M. CAGNET. *Rev. Opt. (Théor. Instrum.)* **29**, 377–83 (*July*, 1950) *In rench.*

If the stray light arising in an optical system is found by measuring visually the illumination at the centre of the image of a hole in a uniformly bright screen, an error arises from diffraction. This diffracted light is calculated and a table of corrections given as a function of the exit pupil diameter and the apparent angular diameter of the hole. The results have been confirmed experimentally using a system without optical components, so that the only stray light present is due to diffraction.

R. W. FISH

535.242.6 : 535.6

7840. On an absolute unit of quantity of colour and its use. A. BIOT. *Ann. Soc. Sci., Brux.*, **64** (*No.* 1–2) 111–14 (1950) *In French.*

The absolute unit is defined so as to correspond to a flux of one lumen of the colour which is represented by the centroid of the colour triangle. By use of this conception the calculation of the resultant effect of two sources of different colour becomes simplified. Other phenomena can be conveniently described in terms of this unit.

N. CORCORAN

535.245

7841. Optical integrator permitting the calculation of the distribution of luminous intensity in the image of an extended object. M. CAGNET. *C.R. Acad. Sci., Paris*, **230**, 2084–6 (*June* 12, 1950) *In French.*

The integrator requires the intensity distribution in the image of a point source to be known and to be axially symmetrical. An opaque screen, having a cut-out representing this distribution, rotates in front of a uniformly illuminated surface. Another screen has a cut-out representing the extended object and the light passing through this screen gives the required intensity distribution and can be measured by a photometer. One case, known from theoretical calculation, has been confirmed with this apparatus.

R. W. FISH

535.247.4

7842. A circumferential recording microphotometer. T. C. O'CONNELL AND A. G. BARKOW. Note in *Rev. Sci. Instrum.*, **21**, 573–4 (*June*, 1950).

535.247.4 : 621.317.39 : 621.327.43

7843. Modern photometry of fluorescent luminaires. G. A. HORTON. *Illum. Engng, N.Y.*, **45**, 458–67 (*July*, 1950).

Describes a versatile distribution photometer capable of handling all fluorescent fixtures including the 8 ft slimline lamps. A photoelectric instrument for measuring lamp brightness is also described. An improved wide-range, zero-resistance photocell circuit is presented. Suitable portable photometers for the measurement of localized lighting characteristics are mentioned. Contemporary methods and practical aspects of fluorescent photometry are mentioned. 34 references are included.

A.

535.247.4 : 523.87

7844. An integrating photometer for low light levels. H. W. BABCOCK. *J. Opt. Soc. Amer.*, **40**, 409–11 (*July*, 1950).

Proper estimation of exposure times in astronomical spectroscopy is often difficult, largely because the quality of the stellar image is so dependent upon "seeing." The integrating photometer described here, while not new in principle, functions with satisfactory sensitivity and stability on only 2% of

the light transmitted by the slit of the coudé spectrograph of the 100 in telescope. When the meter indicates a predetermined number of counts, the finished spectrogram will have the proper density regardless of seeing, slit width, passing clouds and efficiency of guiding. A.

535.31

7845. Simple deduction of the eiconal theorem. R. GANS. *Rev. Un. Mat. Argentina*, **14**, 3–15 (1949) *In Spanish.*

The Euler equations for the path of a light ray are stated. Specialization to paraxial rays in an axially symmetric system leads to linearized equations, and the solutions of these account for the terms of next higher order by a variation of the parameters. MATHEMATICAL REVIEWS

535.313.6

7846. On the design of wide angle Schmidt optical systems. E. M. WORMSER. *J. Opt. Soc. Amer.*, **40**, 412–15 (*July*, 1950).

A method of balancing the optical aberrations over a wide angular field of a Schmidt optical system is described. This design method is demonstrated for a Schmidt optical system of focal ratio $F:0{\cdot}7$ and covering an angular field of 40°. The reduction in off-axis secondary aberrations is obtained by computing a "wide angle" aspheric corrector plate through the use of "Lucy's Approximate Method" instead of using the conventional "exact equations." A.

535.317

7847. On certain pancratic systems. A. BIOT. *Ann. Soc. Sci., Brux.*, **64** (*No.* 1–2) 93–110 (1950) *In French.*

A pancratic system of 2 lenses has 2 conjugate planes at a fixed distance apart. The magnification depends upon the positions of the lenses and their powers. Gaussian optics gives the relationships between the main variables of the system and yields the conditions necessary in a practical variable magnification system. The special case with both conjugate planes at infinity is also considered. The results are applied to the design of a 2-lens erector system for a telescope. R. W. FISH

535.317

7848. Tracing of skew rays. D. P. FEDER. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 61–3 (*July*, 1950).

This paper presents a set of convenient recurrence formulas for the tracing of skew rays by means of a desk calculator. Because of the increased speed and field coverage of modern lenses, it is frequently desirable to trace such rays in making a complete study of an optical system. The formulas apply to systems of spherical refracting surfaces. The system need not be centred. Particularly convenient check formulas are available, which need be applied only at the final surface. A.

535.317.4

7849. Transmission factors for objectives affected by spherical aberration. S. M. J. RÉGNIER. *Rev. Opt. (Théor. Instrum.)* **29**, 315–22 (*June*, 1950) *In French.*

The intensity in the diffraction image of a point source is calculated for wavefronts with spherical aberrations of $\lambda/4$, $\lambda/2$, $3\lambda/4$ and λ and for square, circular and lozenge shaped apertures. The curv so obtained are used to determine the variation of t limit of visibility for a Foucault test pattern as function of the spherical aberration and aperture an objective. R. W. FI

535.317

7850. Tolerance of spherical aberration. C. MORA *Ottica*, **3**, 21–49 (1949) *In Italian.*

A special form for the wave surface is proposed the best type of correction for the axis point of optical system in the presence of aberration up to t 7th order. The influence of spherochromatic aberr tions is investigated. The paper is based on Rayleigh quarter wavelength criterion. MATHEMATICAL REVIEV

535.318 : 771.3

7851. On the depth of focus of photograph objectives. D. HACMAN. *Optik*, **6** (*No.* 5) 273– (1950) *In German.*

The depth of focus is derived by geometric theor and the effect of spherical aberration and vignetti of the lens determined. The intensity distributi near the paraxial image is calculated in the presen of 3rd and 5th order spherical aberration. The dep of focus is then shown to be larger than expected fro geometric theory. A photographic film of fin thickness leads to a reduced depth of focus for o axis images. Comparison with wave theory sho that these geometric results apply under norm conditions of use, unless the lens is considerab stopped down. R. W. FI

535.

7852. On the question of the light path in tot reflection. H. WOLTER. *Z. Naturforsch.*, **5a**, 276– (*May*, 1950) *In German.*

The path is defined as a succession of points zero intensity. In connection with the problem the lateral displacement of a ray in total reflectio there is a discussion of the behaviour of amplitud phase, etc., of a plane wave at all points near t totally reflecting plane surface. It is shown that the are regions in which the time-averaged energy lin are closed. L. PINCHER

535.32 : 535.

7853. Diffraction at a [black, conducting] straig edge of finite thickness and its relation to the later shift of totally reflected rays. K. ARTMANN. *An Phys., Lpz.*, 7 (*No.* 5) 209–12 (1950) *In German.*

The lateral shift occurring in (1) calculated by ti author [Abstr. 7918 (1950)] will not affect calculatio from the author's theory [Abstr. 3217 (1948)] of (as measured by Goos and Hänchen [Abstr. 48 (1950)], because they increased the effect about times by multiple reflections. For a single tot reflection and for a diaphragm of thickness 1 000 the two effects are comparable when the angle incidence is $\frac{1}{2}°$ greater than the critical angle. TI paper includes criticism of the theory of (2) given b Fragstein [Abstr. 4808 (1950)]. G. F. LOTHIA

535.321 : 548

7854. Calculation of the indices of refraction billietite. H. BRASSEUR. *Bull. Soc. Roy. Sci. Liège* **19**, 242 (*May*, 1950) *In French.*

By the method of Abstr. 6824 (1950), $\alpha = 1{\cdot}7$ $\beta \doteq \gamma = 1{\cdot}85$. A. J. C. WILSO

535.324

55. Dispersion measurements in the infra-red by eans of a parallel-sided plate. W. BRÜGEL. *Optik*, No. 5) 293–8 (1950) *In German.*

A parallel pencil of radiation falls on a parallel led plate, and the refractive index is calculated from e lateral deviation of the beam. The angle of cidence is chosen so as to minimize the effect of rors of observation. The path of the emergent diation is located by a suitable spectrometer. sing the apparatus described an accuracy of a few its in the 3rd decimal place is claimed. No perimental results are given. N. CORCORAN

535.33

856. An ultraviolet multiplet table. C. E. MOORE. irc. Nat. Bur. Stand., Wash. (No. 488) 78 pp. (1950).

The first section of an ultra-violet extension to the evised Multiplet Table of 1945. The work is being one in conjunction with the series on "Atomic nergy Levels" [Abstr. 665, 7202 (1949)], and this ction includes selected spectra (79) of the first 23 ements, H through V, the same elements as Vol. I f "Atomic Energy Levels."

535.33.03

857. A high intensity ultraviolet continuum source or use in spectrophotometry. N. A. FINKELSTEIN. Rev. Sci. Instrum., **21,** 509–11 (*June*, 1950).

A high intensity ultraviolet continuous spectrum .c. source emitting between 50 and 100 times as uch light as comparable commercial sources has een designed and constructed. Transitions between wo molecular energy states of H are induced to roduce a continuum from 1 850 Å to 6 000 Å. The rc is run at approximately 14 A and 90 V from a 20 V d.c. line. A H pressure of 3 mm of Hg is used. Lifetimes greater than 40 hr have been obtained. A.

535.33.03 : 537.523.5

7858. The carbon arc as an infra-red source. C. S. RUPERT AND J. STRONG. *J. Opt. Soc. Amer.*, **40,** 455–9 (*July*, 1950).

The desirability of very high temperature sources for i.r. spectroscopy is pointed out. The crater radiation of the low intensity C arc is examined and recommended for practical use in this application. Details of arc mounting and use are given. A.

535.33.07–15

7859. Comatic aberration in infra-red spectrometer design. F. P. ELBY. *J. Opt. Soc. Amer.*, **40,** 450–4 (*July*, 1950).

Comatic images formed by off-axis rays reflected from a good ellipsoidal mirror were studied experimentally. Horizontal and vertical knife edges were used to chop slices of these images, and the alternating current output of a photo-multiplier tube, proportional to the chopped radiation, was used to indicate the intensity distributions in the comatic images. Calculations of intensity distributions in comatic images were made, and the experimental observations were predicted from them satisfactorily. Infrared detector sensitivity is inversely proportional to the square root of the detector area. Accordingly, the intensity distribution in the comatic image may be used to calculate optimum dimensions for both the exit slit and the detector in an i.r. spectrometer. A.

535.33.07–15

7860. A recording double-beam infra-red spectrophotometer. I. A. BROWNLIE. *J. Sci. Instrum.*, **27,** 215–18 (*Aug.*, 1950).

The automatic balancing of two beams of radiation from the same source is designed to eliminate variations in the spectrum caused by atmospheric absorption, changes in source radiation intensity, and drifts in the electronic amplification. The i.r. absorption spectrum of any chemical compound can thus be recorded directly as percentage of radiation absorbed *v.* wavelength. If in solution, the solvent can be placed in the other beam, and the absorption due to the compound alone can thus be ascertained. The optical system is basically similar to that of the instrument by Baird Associates. Schwartz thermopile type F 1440 by Hilger is used instead of a bolometer. Slits of a new type of design are used, and a d.c. servo system is employed for the recorder and light balancing mechanism. The spectral region covered is from 2 to 16 μ, and recording time is from 12 min upwards. A.

535.338.1

7861. On the emission spectra of hydrogen sulphide excited by electronic impacts. Emission spectrum of the radical SH. S. LEACH. *C.R. Acad. Sci., Paris*, **230,** 2181–2 (*June* 19, 1950) *In French.*

H_2S at 5 mm Hg pressure excited at 2 kV gave a complex spectrum containing about 50 lines between 3 236 and 3 320 Å belonging to the (0, 0) band of the $^2\Sigma$–$^2\Pi_i$ transition in SH. Constants are calculated for various states. S. T. HENDERSON

535.338.33

7862. Spectroscopic phenomenon produced by the Tesla spark. H. TRICHÉ. *C.R. Acad. Sci., Paris*, **230,** 1659–61 (*May* 8, 1950) *In French.*

The emission spectrum of Fe produced by a Tesla discharge differs from that of Fe sulphide by changes in the relative intensities of lines in the same multiplet. S. T. HENDERSON

535.338.332

7863. Atomic spectroscopy with separated isotopes. W. WALCHER. *Nucleonics*, **6,** 28–36 (*June*, 1950).

The method of examining hyperfine structure by means of the Fabry–Pérot etalon is described. The measurement of relative intensities and separations of multiplet components, which are important in establishing nuclear properties such as spin and magnetic moment, is often facilitated by isotope separation, since the difference in these properties between isotopes can lead to confusing overlapping in the h.f.s. of the natural element. A form of optical mass spectroscopy is described, based on the isotopic displacement of h.f.s. components and the fact that the intensity of a component due to a given isotope is proportional to the relative abundance of that isotope in the element whose h.f.s. is being observed. L. R. SHEPHERD

535.338.332

7864. Hyperfine structure of $4^{1,3}F - nG$ of the spectrum of Al II. S. SUWA. Letter in *Phys. Rev.*, **78,** 810–11 (*June* 15, 1950).

535.338.332

7865. The hyperfine structure of Ni^{61}. K. G. KESSLER. Letter in *Phys. Rev.*, **79**, 167 (*July* 1, 1950).

535.338.332 : 539.152.2

7866. Hyperfine structure and nuclear spin of yttrium, $^{89}_{39}Y$. H. KUHN AND G. K. WOODGATE. *Proc. Phys. Soc., Lond. A*, **63**, 830–2 (*Aug.*, 1950).

By the use of a liquid-air-cooled hollow-cathode tube with very low current densities it was possible to resolve hyperfine structure in the arc spectrum of Yt. The value of the nuclear spin was found to be $I = \frac{1}{2}$ and the sign of the magnetic moment to be negative. This agrees with recent results of Crawford and Olson, who determined the nuclear spin from the intensity ratio of a hyperfine-structure doublet in the second spark spectrum of Yt. A.

535.338.332 : 539.152.2

7867. Hyperfine structure and nuclear spins of tungsten and tellurium. G. R. FOWLES. *Phys. Rev.*, **78**, 744–7 (*June* 15, 1950).

By the use of enriched isotopes, hyperfine structure in the optical spectra of Te^{123}, Te^{125} and W^{183} has been observed. Milligram amounts of the isotopes were used in a modified Schüler hollow-cathode discharge tube. In the visible region, 4 000 to 6 000 Å, about a dozen lines of singly ionized Te showed hyperfine structure, all of them giving just 2 components for the odd isotope. Te^{123} and Te^{125} gave identical structures except for a scale factor, the total splitting of the lines of Te^{123} being about 88% of that of Te^{125}. In the spectrum of neutral W, all of the lines which show the isotope shift for natural W gave just 2 components with highly enriched W^{183}. The number of hyperfine-structure components, namely 2, gives for Te^{123}, Te^{125} and W^{183} a nuclear spin of $\frac{1}{2}$. This was also verified by intensity measurements. A.

535.338.334 : 537.523.5

7868. On the widening of spectral lines under the influence of ions and electrons. S. L. MANDELSHTAM AND N. N. SOBOLEV. *J. Exp. Theor. Phys., USSR*, **20**, 323–9 (*April*, 1950) *In Russian.*

The problem of the limits of applicability of collision and statistical conceptions to the interpretation of the broadening of spectral lines by the electric fields of ions and electrons in the plasma of a gas discharge was investigated. The results obtained are applied to the broadening of the lines in the column of the electric arc. A comparison of the results of both theories, i.e. collision broadening for lines with a linear effect [Reman, "Lijnverbreeding in de licht boog," Utrecht, 1937] with the statistical broadening by ions according to Holtsmark [*Z. Phys.*, **12**, 56 (1936)] shows that the results are roughly identical, which also accounts for the deviation from Holtsmark's theory of the form of the H and Li lines observed by Reman. The calculations of the author do not claim to be more than a first approximation, especially in the case of lines with a linear Stark-effect and large quadratic effect. B. F. KRAUS

535.338.42

7869. The contour of an unresolved molecular band —study of the Swan bands of C_2. C. FEHRENBACH. *Ann. Astrophys.*, **13**, 170–80 (*April–June*, 1950) *In French.*

A method of computing the contour of an unresolved band is described (ignoring spectrographic imperfections other than slit width) and applied to the Swan bands. Tables of the numerical data required for the latter are given for temperatures 2 500, and the effects on the band contours of varying temperatures and slit-widths are illustrated.

D. L. EDWARDS

535.343

7870. Optical absorption spectrum of thulium sulphate. H. GOBRECHT. *Ann. Phys., Lpz.*, 7 (*No.* 1–2) 88–92 (1950) *In German.*

Results are given of a new experimental research work on the absorption spectrum of Tm^{+++}. Purest $Tm_2(SO_4)_3$ was used. The spectrograms show a distinct absorption in the u.v. (at 360 mμ and 300–260 mμ). F. LACHMAN

535.343–14

7871. Molecular microwave spectra tables. P. KISLIUK AND C. H. TOWNES. *J. Res. Nat. Bur. Stand., Wash.*, **44**, 611–42 (*June*, 1950).

This paper presents a group of tables that give the frequencies, assignment of quantum numbers, and intensities of over 700 microwave absorption lines. The best available values of other pertinent molecular data, such as moments of inertia, dipole moments, quadrupole coupling constants and rotation-vibration constants are also included. The frequencies are listed once for each molecule and again in consecutive ascending order of frequency. References are given for all data included. Frequencies listed to the nearest megacycle were generally measured with a cavity wave meter and may be in error by as much as 10 megacycles, whereas those given to a fraction of a megacycle are generally known to an accuracy of about 0·1 megacycle. A short discussion of microwave spectra and important formulas is given. For easy calculation of hyperfine structure Casimir's function is tabulated up to $J = 10$ and $I = 9/2$. A.

535.343–15

7872. Motions of molecules in condensed systems. VI. The infra-red spectra for vapor, liquid, and two solid phases of methyl chloroform. R. KARPLUS AND R. S. HALFORD. *J. Chem. Phys.*, **18**, 910–12 (*July*, 1950).

Infrared spectra are compared for equivalent absorbing paths of methyl chloroform (1, 1, 1-trichloroethane) as vapour at 25°, liquid at — 28°, solid I at — 40° and solid II at — 55°C. The spectra differ in the respects: (1) *P-Q-R* branches observed on some bands in the vapour disappear in the condensed phases, (2) bands generally are sharpened and ones attributable to combinations are intensified by condensation, and (3) three weak bands at 830, 1 288 and 1 313 cm^{-1} are present in the condensed states only. Although selection rules for the vapour exclude only the torsional mode and its combinations with other, totally symmetric ones, these weak bands would yield what appears to be the unreasonably high value of 300 cm^{-1} for the torsional frequency. The fundamental frequencies are discussed briefly and it is pointed out that the spectra are almost entirely

explicable upon the basis of only 10 of the 12 expected ones for this molecule. A.

535.343–15

7873. Infrared spectra of bromochloromethane, dibromomethane, tribromochloromethane, and tetrabromomethane. E. K. PLYLER, W. H. SMITH AND N. ACQUISTA. *J. Res. Nat. Bur. Stand., Wash.*, **44**, 503–8 (*May*, 1950).

535.343–15 : 539.132

Vibrational intensities. I. Theory of diatomic infra-red bands. *See Abstr.* 8152

535.343.2

7874. Absorption spectra of tetravalent uranium salts: attempt at classification from frequencies of vibration. M. FREYMANN, R. FREYMANN, R. ROHMER AND P. HAMON. *C.R. Acad. Sci., Paris*, **230**, 1524–6 (*April* 24, 1950) *In French.*

The absorption spectra of UCl_4 and UBr_4 have been measured. A tentative classification of the absorption of U^{+4} compounds is advanced on the basis of ascertained frequencies of absorption and extrapolated values for Raman frequencies.

W. R. ANGUS

535.343.2

7875. Optical absorption edge for BaO as determined by the method of Ives and Briggs. E. A. TAFT AND J. E. DICKEY. Letter in *Phys. Rev.*, **78**, 625 (*June* 1, 1950).

Confirms Tyler's result [Abstr. 3048 (1950)] by a photo-electric method.

535.343.2 : 535.323

7876. Dispersion of the crystals of phenanthrene and anthracene at low temperatures. A. YU. EICHIS. *J. Exp. Theor. Phys., USSR*, **20**, 471–3 (*May*, 1950) *In Russian.*

The dispersion was experimentally determined by Obreimov's method [Abstr. 3873 (1949)] and the magnitudes of the effective vibrator forces calculated for the first electron transitions in phenanthrene and anthracene crystals at temperatures of the order $-130°C$. B. F. KRAUS

535.343.32

7877. The absorption spectrum of element 61, promethium. G. W. PARKER AND P. M. LANTZ. *J. Amer. Chem. Soc.*, **72**, 2834–6 (*July*, 1950).

The absorption bands of Pm in the visible spectrum are observed to resemble those of Nd both in number and in intensity, but are distinctly separable from them by at least 8 mμ. They are in the same position and of the same magnitude for both the chloride and nitrate solutions. The most prominent are $493{\cdot}5 \pm 0{\cdot}5$, $548{\cdot}5 \pm 0{\cdot}5$, $568{\cdot}0 \pm 0{\cdot}2$, $685{\cdot}0 \pm 0{\cdot}1$, $702{\cdot}7 \pm 0{\cdot}3$, $737{\cdot}2 \pm 0{\cdot}2$ and $785{\cdot}0 \pm 0{\cdot}1$ mμ. A.

535.343.32–14

7878. Microwave spectra and molecular structures of methyl cyanide and methyl isocyanide. M. KESSLER, H. RING, R. TRAMBARULO AND W. GORDY. *Phys. Rev.*, **79**, 54–7 (*July* 1, 1950).

Certain of the pure rotational lines of methyl cyanide and methyl isocyanide have been measured and the following molecular properties have been obtained. The moments of inertia, I_B, $\times 10^{-4}$ g cm^2, are: for $C^{12}H_3C^{12}N^{14}$, $91{\cdot}20_{34}$; for $C^{12}H_3C^{13}N^{14}$, $91{\cdot}24_{86}$; for $C^{12}D_3C^{12}N^{14}$, $106{\cdot}76_{66}$; for $C^{12}D_3C^{13}N^{14}$, $106{\cdot}89_{48}$; for $C^{12}H_3N^{14}C^{12}$, $83{\cdot}45_{50}$; for $C^{12}H_3N^{14}C^{13}$, $86{\cdot}52_{77}$; for $C^{12}D_3N^{14}C^{12}$, $97{\cdot}75_{79}$; and for $C^{12}D_3N^{14}C^{13}$, $101{\cdot}33_{91}$. The molecular dimensions are: for CH_3CN, $d_{CH} = 1{\cdot}092$Å, $d_{CC} = 1{\cdot}460$Å, $d_{CN} = 1{\cdot}158$Å and $\angle HCH = 109°8'$; for CH_3NC, $d_{CH} = 1{\cdot}094$Å, $d_{CN} = 1{\cdot}427$Å, $d_{NC} = 1{\cdot}167$Å and $\angle HCH = 109°46'$. The nuclear coupling for N^{14} is $-4{\cdot}35$ Mc/sec in CH_3CN and is $< |0{\cdot}5|$ in CH_3NC. A.

535.343.4–14

7879. The microwave rotational spectrum and structure of bromogermane. A. H. SHARBAUGH, B. S. PRITCHARD, V. G. THOMAS, J. M. MAYS AND B. P. DAILEY. Letter in *Phys. Rev.*, **79**, 189 (*July* 1, 1950).

535.343.4–14

7880. Preliminary analysis of the microwave spectrum of ketene. B. BAK, E. S. KNUDSEN, E. MADSEN AND J. RASTRUP-ANDERSEN. Letter in *Phys. Rev.*, **79**, 190 (*July* 1, 1950).

535.343.4–14 : 533.7

7881. Microwave collision diameters. I. Experimental. R. R. HOWARD AND W. V. SMITH. *Phys. Rev.*, **79**, 128–31 (*July* 1, 1950).

The diameters of 15 polar and non-polar gases for collisions with ammonia are obtained from measurements of the pressure broadening of the ammonia 3–3 inversion line in the mixed gases at low pressures. The design of the spectroscope used and the experimental technique involved are discussed. A.

535.343.4–14 : 533.7

7882. Microwave collision diameters. II. Theory and correlation with molecular quadrupole moments. W. V. SMITH AND R. HOWARD. *Phys. Rev.*, **79**, 132–6 (*July* 1, 1950).

Observed microwave collision diameters are interpreted as arising exclusively from transitions induced during the collision. Collision diameters greater than kinetic theory values arise from dipole-dipole or dipole-quadrupole interactions. The former case affords a quantitative test of the theory. In the latter case measurements of collision diameters yield quadrupole moment measurements which are correlated with molecular structure. A.

535.343.4–31

7883. Absorption bands in the Schumann–Runge system of O_2 under high pressures and temperatures. A. HERCZOG AND K. WIELAND. *Helv. Phys. Acta*, **23** (*No.* 4), 432–6 (1950) *In German.*

Under high pressures $(O_2)_2$ molecules are formed which cause broad triplet bands in the absorption spectrum. This becomes continuous towards 2 400 Å, and overlaps the shortwave length Schumann–Runge region. These investigations support the view of loosely bound $(O_2)_2$ molecules for at high temperatures (1 070°c) the spectrum shows sharp bands. A rotational analysis of the long-wavelength end is given. In this region (2 450–2 650 Å) the absorption and emission spectra just overlap. J. JACOBS

535.343.4–31

7884. Absorption of ozone in the ultraviolet. E. VIGROUX. *C.R. Acad. Sci., Paris*, **230**, 2277–8 (*June* 26, 1950) *In French.*

Reports the difference in absorption coefficients of

adjacent pairs of maxima and minima in the Huggins bands (3 106–3 372 Å) for temperatures $-92°$ to $+120°$; the differences are smaller at higher temperatures. Bands in the range 3 391–3 795 Å have been measured photographically at 18°c; there are 24 maxima—the four at $\lambda > 3\,654$ Å are so weak, that no intensity measurements were possible.

G. F. LOTHIAN

535.343.4–32

7885. Absorption spectrum of indium vapour in the Schumann region. W. R. S. GARTON. Letter in *Nature, Lond.*, **166**, 150 (*July* 22, 1950).

535.345.1

7886. Spectral transparency of vitreous silica after the passage of electric current at high temperature. E. DARMOIS, R. BAUPLÉ, A. GILLES AND N. ASTOIN. *C.R. Acad. Sci., Paris*, **230**, 1851–3 (*May* 22, 1950) *In French.*

Electrolysis of German "Homosil" at high temp. ($< 1\,000$°c) produced little apparent change, but an increase in ultra-violet transparency. A less pure French material gave several coloured zones between anode and cathode by the same treatment. Some of these zones had an absorption peak near 4 000 Å attributed to SiO.

S. T. HENDERSON

535.345.1

7887. Permanence of glass standards of spectral transmittance. K. S. GIBSON AND M. A. BELKNAP. *J. Res. Nat. Bur. Stand., Wash.*, **44**, 463–73 (*May*, 1950). Shorter version in *J. Opt. Soc. Amer.*, **40**, 435–7 (*July*, 1950).

Shortly after the introduction of commercially available photoelectric spectrophotometers, the National Bureau of Standards began issuing calibrated discs for checking the photometric scale of spectrophotometers. At the time these standards were selected no precise information was available regarding their permanence. The present paper presents data showing that the glass standards kept in the files for 16 years with only occasional use have not changed. Data are also given showing the nature of the changes occurring in glasses similar to the standards when exposed under glass to south skylight (including sunlight) for periods up to 3 years.

A.

535.345.1–31 : 666

7888. Soft soda glass to transmit bactericidal radiation. J. E. STANWORTH. *Brit. J. Appl. Phys.*, **1**, 182–3 (*July*, 1950).

Small amounts of Fe, Ti, S and I have a marked effect on the transmission of short-wavelength ultraviolet light. Provided due care is taken to keep these impurities to a minimum and to melt under suitable (reducing) conditions, soft glasses of a variety of compositions can be made having excellent transmission at 2 537 Å.

A.

535.345.6

7889. Infra-red transmitting filters. II. The region 1 to 6μ. E. R. BLOUT, R. S. CORLEY AND P. L. SNOW. *J. Opt. Soc. Amer.*, **40**, 415–18 (*July*, 1950).

A type of visible-absorbing, i.r.-transmitting filter is described in which the absorbing units are produced from a plastic film that also serves as a supporting medium. Filters of this kind prepared from polyvinyl chloride and polyvinylidene chloride films are characterized by transmission bands between 1 and 3·3 μ and between 3·5 and 5·8 μ. Ways of isolating either of these bands are described. Such filters have obvious utility in connection with photo-conductive cells.

A.

535.37

7890. Observations on exceptional duration of mineral phosphorescence. H. E. MILLSON AND H. E. MILLSON, JR. *J. Opt. Soc. Amer.*, **40**, 430–5 (*July* 1950).

The purpose of the present investigation was to obtain data concerning the duration of phosphorescence of minerals. Some minerals with protracted emissions have been discovered and the features of their phosphorescence determined with dark-adapted eyes, and in some cases, with photographic film. Studies have shown that the phosphorescence caused by a short exposure to 2 437 Å ultraviolet rays will continue for a long period of time. Dark-adapted eyes were used to determine the duration of coloured and colourless phosphorescence and photographic film was used to obtain phosphorographs and thereby record the emission of light long after it became imperceptible to the eye. Protracted phosphorescence has been discovered in calcite, fluorite, spodumene, wernerite, willemite, and synthetic phosphors. After an initial exposure of one minute, Texas calcite emitted an afterglow which was distinguishable to dark-adapted eyes for 4 600 hr and was capable of producing a photographic image after more than $5\frac{1}{2}$ yr. Fluorite from Trumbull, Connecticut, similarly exposed, continued to emit a phosphorescence perceptible to the eye for more than 4 years. The Texas calcite, fluorite and spodumene are still phosphorescing. Data on colour and duration of visible phosphorescence of natural minerals are tabulated.

A.

535.371 : 537.311.33

7891. Theory of luminescence and electrical conductivity of cadmium sulphide crystals. I. BROSER AND R. WARMINSKY. *Ann. Phys., Lpz.*, **7** (*No.* 6) 289–311 (1950) *In German.*

A quantitative study is made of the mechanisms of luminescence and electrical conductivity in CdS crystals in terms of the Riehl–Schön energy-band model. Factors such as the temperature, impurity concentration and thickness of excited crystal layer are accounted for. Agreement is shown with experimental results.

G. F. J. GARLICK

535.375.5

7892. An explanation of a point which remained obscure in Lennuier's experiments. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci., Paris*, **230**, 1832–4 (*May* 22, 1950) *In French.*

Lennuier showed that a resonance line $\nu_0 = \nu_B - \nu_A$ is excited also by a frequency ν_1, near to ν_0, but spectrally distinguishable from it. When $\nu_1 > \nu_0$ the phenomenon is similar to a Raman effect. It is suggested that when $\nu_1 < \nu_0$ the small energy $\nu_0 - \nu_1$ is provided by thermal radiation from the environment, whose intensity is such that the phenomenon is symmetrical with respect to the sign of $\nu_0 - \nu_1$.

L. PINCHERLE

535.375.5

7893. Raman spectrum of 1,3-butadiene in the gaseous and liquid states. C. M. RICHARDS AND J. R. NIELSEN. *J. Opt. Soc. Amer.*, **40**, 438–41 (*July*, 1950).

The Raman spectrum of gaseous, 1,3-butadiene has been photographed with a 3-prism glass spectrograph of linear dispersion 15 Å/mm near 4 358 Å. Polarization data have been obtained for the liquid. The observed Raman spectrum has been interpreted in some detail in terms of a planar *trans*-configuration of the molecule. Two fundamentals have been added to previous assignments, and several assignments have been made more specific. It is concluded that at room temperature a small fraction of the molecules have a *cis*-configuration. A.

535.375.5

7894. Raman spectra of *cis*- and *trans*-2-butene in the gaseous and liquid states. C. M. RICHARDS AND J. R. NIELSEN. *J. Opt. Soc. Amer.*, **40**, 442–5 (*July*, 1950).

The Raman spectra of gaseous and liquid *cis*- and *trans*-2-butene have been obtained with a 3-prism glass spectrograph of linear dispersion 15 Å/mm at 4 358 Å, together with polarization data for these compounds in the liquid state. For each compound 6 or 7 fundamentals have been added to previous assignments, and one change has been made in the latter. The observed spectra have been interpreted in detail. A.

535.375.5

7895. The Raman spectrum of trichloroacrylic acid $CCl_2 = CCl \cdot COOH$. H. GERDING AND H. G. HARING. *Rec. Trav. Chim. Pays-Bas.*, **69**, 935–40 (*July–Aug.*, 1950).

535.375.5

7896. The Raman spectrum of trichloro acrylic acid chloride. H. GERDING AND J. DE BOER. *Rec. Trav. Chim. Pays-Bas*, **69**, 941–3 (*July–Aug.*, 1950).

535.375.5 : 541.65

7897. The Raman spectra of the monodeuterated toluenes. C. H. SMITH, A. R. CHOPPIN AND O. A. NANCE. *J. Amer. Chem. Soc.*, **72**, 3260–1 (*July*, 1950).

The Raman spectra of the deuterated toluenes have been measured and compared with the infrared spectra. Examination of the frequencies in the region of the C–D stretching frequencies indicates that doubling in the spectrum of toluene-4-*d* is due to Fermi resonance with the combination 1 493 + 784. This implies that the 1 493 cm^{-1} band belongs to symmetry class A_1. The C–D stretching frequencies also indicate that the C–H force constant in the meta position is larger than the corresponding constant for the ortho position. A.

535.375.5 : 541.65

7898. A Raman effect study of the compound $HNO_3 \cdot 2\,SO_3$. H. GERDING, J. W. M. STEEMAN AND L. J. REVALLIER. *Rec. Trav. Chim. Pays-Bas.*, **69**, 944–8 (*July–Aug.*, 1950).

The Raman frequency shifts of the compound $HNO_3 \cdot 2\,SO_3$ in the liquid state at about 120° are given. The depolarization factors of the majority of the Raman lines have been determined. The strongest Raman line of the spectrum with $\Delta\tilde{\nu} =$ 1 402 cm^{-1} (15s, 0·12) is typical for the nitronium ion NO_2^+. The compound $HNO_3 \cdot 2\,SO_3$ has to be considered in all probability as $NO_2^+ \cdot HS_2O_7^-$. A.

535.376

7899. Stimulation of the fluorescence of organic substances by α-particles and by γ-rays. L. HERFORTH. *Ann. Phys., Lpz.*, 7 (*No.* 6) 312–20 (1950) *In German.*

The transparency and fluorescence intensity of a number of organic compounds (chiefly aromatic hydrocarbons) in layers of different thicknesses and ground to various extents, as excited by α-particles (from Po) and by γ-rays (from Ra), are tabulated. Curves relating the relative fluorescence intensities with the wavelengths of the fluorescence show marked maxima, except with coronene. No relationship could be traced between the values obtained and the chemical constitution (including the no. of double bonds) of the compounds, but the cryst. size and state of subdivision of the specimen markedly influenced the transparency. See Abstr. 3715 (1948).
J. GRANT

535.376

7900. Behaviour of electron traps in the phenomena of electrophotoluminescence. J. MATTLER AND D. CURIE. *C.R. Acad. Sci., Paris*, **230**, 2086–8 (*June* 12, 1950) *In French.*

Study of the transient emission produced when an electric field is applied to a sulphide phosphor at different times after excitation by X-rays, u.v. or α-particles gives information on the depths of electron traps emptied. A second field application provides evidence of retrapping. G. F. J. GARLICK

535.376

7901. A characteristic example of re-trapping in phosphorescence. D. CURIE, JR. Letter in *Nature, Lond.*, **166**, 70 (*July* 8, 1950).

535.39

7902. The optical admittance of homogeneous and heterogeneous films. B. S. BLAISSE. *J. Phys. Radium*, **11**, 315–20 (*July*, 1950) *In French.*

The impedance Z has to be defined as the ratio of two quantities so that Z always varies continuously with the thickness of the film, even if the refractive index varies discontinuously. The ratio E_t/H_t satisfies this condition, where E_t and H_t are the components of the electric and magnetic vectors E and H parallel to the plane separating the two different media. If the impedance Z_t is known, the coefficient of reflection R_t can be easily calculated. The values of E and H in a plane parallel to the surface of a film can be deduced from the two values $E_{t'}$ and $H_{t'}$ in another plane by means of two linear equations; the film between the two planes behaves like an optical quadrupole. By decreasing the thickness of this film indefinitely, one can derive a differential equation of the first order for the impedance and 4 simultaneous differential equations for the 4 coefficients of the quadrupole. The special case where the inverse of the refractive index varies linearly with the thickness of the transparent film is considered. For the case of normal incidence it is found that the "reduced" impedance Z (defined as the product of the impedance and the refractive index) as a function of the thickness describes a circle in the complex plane Z. A.

535.39

7903. Graphical study of the optical properties of thin metallic films. D. MALÉ. *J. Phys. Radium*, **11**, 332–6 (*July*, 1950) *In French.*

The treatment starts from the results obtained by applying the boundary conditions of the electromagnetic theory of light to an absorbing layer deposited on a transparent base. By means of a nomogram formed of two families of orthogonal curves, the Fresnel reflection factors at the interfaces are first determined. By tracing a logarithmic spiral, the reflection and transmission factors and the changes of phase on reflection are then determined. The nomogram enables the behaviour of the curves to be quickly determined and the positions of the maxima and minima of these factors to be ascertained. A.

535.39

7904. Transmission and reflection theory in systems of multiple thin films. F. SCANDONE. *J. Phys. Radium*, **11**, 337–41 (*July*, 1950) *In French.*

Systems of multiple thin films, either conducting or dielectric, have recently found applications in optics for various purposes, in particular for making radiation filters of more or less narrow band widths. Several papers have been published on the procedure for calculating the radiation transmitted or reflected by any system of thin and parallel films. The resulting formulae are generally rather complicated. In the present contribution, formulae are developed which lead to expressions of very simple structure and which can easily be applied to the case of continuously variable media. A.

535.39

7905. The reflection of light on glass supporting multiple thin films. A. VASICEK. *J. Phys. Radium*, **11**, 342–5 (*July*, 1950) *In French.*

Step-by-step calculations can be made by an extension of a method used by P. Rouard (starting from the last layer and working back to the first), or by the author's alternative method (starting from the first layer and progressing to the last, making use of an auxiliary phase angle). The calculations are rather simple with the first method. One important application is that to non-homogeneous film, which can be thought of as divided in a number of parallel homogeneous layers (say 5), and treated as a multiple film. A.

535.39 : 518.4

7906. Graphical study of the theoretical optical properties of thin films. P. COTTON. *J. Phys. Radium*, **11**, 321–6 (*July*, 1950) *In French.*

The method explained permits a simple evaluation of sometimes complicated results of theoretical calculations. It uses a graphical representation of calculations with complex numbers. After the study of the case of a simple interface (Fresnel coefficients) the case of a single film, absorbing or non-absorbing, is examined, and then the method is generalized for the case of double or multiple films. A.

535.39 : 535.417

7907. Application to thin films of the theory of the reflection interference etalon. C. DUFOUR. *J. Phys. Radium*, **11**, 327–31 (*July*, 1950) *In French.*

The theory of the etalon used in reflection shows that the phase change on reflection from the second mirror does not affect the intensity distribution in the interference pattern. The first film, however, is involved through its transmission coefficient, its reflection coefficients and the angle $\gamma = \alpha + \alpha' - 2\beta$, where α, α' are the phase changes on reflection and β is the phase change on transmission. In the simplified theory, valid for semi-transparent, non-absorbing films, it is assumed that all the phase changes are 0 or π and therefore $\gamma = 0$. In the general case of absorbing films a graphical method has been developed allowing a limit to be found for γ depending on the absorption of the semi-transparent film. The knowledge of an upper limit of γ provides information on the limits of application of the simplified theory of the reflection etalon or of the interference filter with 3 films used in reflection. It has also allowed evaluation of the error due to assuming $\gamma = 0$ in the calculation of the absorption of multiple films of small absorption from the absorption of a single film. A.

535.39 : 535.51

7908. Polarimetric method of thin film study by variation of the refractive index in the region of incidence (immersion). F. SUHNER. *J. Phys. Radium*, **11**, 366–72 (*July*, 1950) *In French.*

The author explains the method used for the study of thin polishing films and of artificial, transparent films on a transparent base, which is either isotropic (glass) or anisotropic (spar). The incident beam of monochromatic, plane polarized light is reflected from the surface to be studied which can be immersed in liquids of varying refractive indices. The ellipticity produced in certain conditions is measured by means of a Chaumont analyser. The results obtained for each surface are interpreted by the simple hypothesis of an approximately homogeneous and invariable film, comparable to a simple layer. The very good agreement within the set of experimental values justifies this hypothesis and allows the calculation of reliable values for the refractive indices and thicknesses, both for polishing films and for the surface films obtained by chemical attack of glass. Analogous methods can be employed for studying transition films and films formed artificially at the interface between two liquids, and also for metallic reflection. A.

535.39 : 535.568

7909. Polarimetric method of studying the heterogeneity of a thin film supported on glass. A. VASICEK. *J. Phys. Radium*, **11**, 346–9 (*July*, 1950) *In French.*

In thin films where the refractive index varies, the difference Δn_1 between indices for the external and internal strata can be taken as a measure of the inhomogeneity of the film. When the path difference is $k\lambda$ (k an integer) it is shown that the polarimetric angle ψ is a known function of Δn_1. Comparison of ψ as measured with the value computed in the assumption of a constant index yields $\Delta\psi \propto \Delta n_1$, thus providing a convenient criterion of inhomogeneity. A.

535.39 : 539.234

7910. Optical properties of thin silicon films. P. COTTON. *J. Phys. Radium*, **11**, 375–9 (*July*, 1950) *In French.*

535.39 : 539.234

Evolution of certain optical properties of very thin metallic films. *See Abstr.* 8260

535.39–14 : 535.23.08

7911. Thin films in the infrared. B. H. BILLINGS. *J. Phys. Radium*, **11**, 407–12 (*July*, 1950) *In French.*

Thin films have found use in infrared light as optical filters, as bolometers and for reducing the amount of reflected light. A thin metal film can also be designed so as to wholly absorb a given wavelength in the infrared band. Two types of filters are described. One is Turner's frustrated reflection filter, which transmits a narrow band in the visible spectrum. The present author has extended its use to infrared and to ultra-short waves of 1 cm wavelength. The second type is the Dennison–Hadley reflecting filter, which reflects a set of infrared bands. A thin metal film of 377 Ω : □ resistance absorbs all the energy in a given wavelength, when placed a quarter wavelength in front of a perfectly reflecting mirror. Such a thin film can constitute a bolometer, thus obviating the difficulty of having a satisfactory black body, which is no longer needed when the thin film is of appropriate resistance. A.

535.412

7912. New localized multiple-beam interference fringes formed with curved thin sheets. S. TOLANSKY AND N. BARAKAT. *Proc. Phys. Soc., Lond. B*, **63**, 545–52 (*Aug.*, 1950).

A description is given of the mode of formation and optical properties of some new sharp localized multiple-beam fringes produced by cylindrically curved thin sheets which are silvered upon both sides. Illumination with strictly parallel monochromatic light leads to sharp line fringes lying in a plane passing through the centre of curvature and perpendicular to the direction of incidence. An approximate theory is developed and checked by observation. The use of mica as the film leads to interesting birefringent doubling effects. These are complicated by differential phase change effects occurring on reflection at the Ag surfaces. Fringe systems have been examined both in reflection and in transmission and related systems obtained with white light used together with a spectrograph. Cleavage step phenomena are revealed by the mica with high precision and high dispersion. It is proposed to name the monochromatic system "fringes of equal tangential inclination." A.

535.417

7913. Test of an optical flat by the Fabry Perot etalon. T. SAKURAI AND K. SHISHIDO. *Sci. Rep. Res. Inst. Tohuko Univ., Ser. A*, **1**, 83–6 (*May*, 1949).

An application of Fabry's fringe method for the examination of optical flats. The flats are mounted as a Fabry–Perot, fringe order being changed by altering gas pressure between the flats. The accuracy of $\frac{1}{50}$th of a light wave is claimed. S. TOLANSKY

535.417

7914. Theoretical study of five-fold films of the type Ag–F_2Mg–Ag–F_2Mg–Ag. C. DUFOUR. *J. Phys. Radium*, **11**, 413–17 (*July*, 1950) *In French.*

The theory of the interferometric combination formed by the coupling of two Fabry–Perot etalons (with two films fused into one) can be applied to 5-fold thin films of the type: metal, non-absorbing film, metal, non-absorbing film, metal. Such complex films can form monochromatic interference filters if certain conditions are fulfilled. Filters of maximum transparence and resolution are obtained if the two outer metal films together are identical with the one metal film in the middle which is much more dense. If the three semitransparent metal films are identical, a dichroitic filter is obtained. The principal interest of this combination of thin films consists in the achievement of great optical density far from the transmission band. A.

535.417

7915. Use in interferometry of combinations of thin films. P. JACQUINOT AND C. DUFOUR. *J. Phys. Radium*, **11**, 427–31 (*July*, 1950) *In French.*

The properties of all interference systems using multiple reflections between partially reflecting films are connected with the reflectivity and absorption of the latter. Attention is drawn to the important improvements which can be obtained by using multiple films of dielectric substances (range of reflectivities below 0·90) or combinations of metallic and dielectric thin films (range of reflectivities over 0·90). The main results obtained are analysed. A.

535.417

7916. A birefringent frustrated total reflection filter. B. H. BILLINGS. *J. Opt. Soc. Amer.*, **40**, 471–6 (*July*, 1950).

In the standard Turner Frustrated Total Reflection filter the pass bands occur in pairs which are oppositely polarized. The maximum theoretical transmission in any band is thus 50%. In this paper it is shown that if the high index layer of the filter is made of a birefringent material the oppositely polarized pass bands can be made to coincide so that the maximum theoretical transmission becomes 100% and the bands occur singly. Measurements are shown on a filter made with such a birefringent layer. A.

535.42

7917. The problem of the pupillary edge. M. DUFFIEUX. *Rev. Opt.* (*Théor. Instrum.*) **29**, 363–76 (*July*, 1950) *In French.*

Continuation of previous article [Abstr. 7168 (1950)] dealing with the boundary effects with rectangular apertures, apodizing systems and during the integration of optical images. Limitations due to the presence of real diaphragms and the structure of real optical materials are discussed. R. W. FISH

535.42 : 535.5

7918. Diffraction of polarized light at stops of finite thickness in the region of the shadow limits. K. ARTMANN. *Z. Phys.*, **127** (*No.* 5) 468–94 (1950) *In German.*

The influence on the intensity distribution of the diffraction pattern by the polarization which occurs at a metallic edge is reviewed. Reference is made to the work of Kirchhoff which yields an approximate solution. By solving the wave equation by the use of Hankel functions an accurate intensity distribution is obtained. The results of the mathematical analysis are given and applied to the studies of Kappler [*Phys. Bl.*, **3**, 162 (1947)]. H. G. JERRARD

535.42 : 535.33

7919. Suppression of diffraction fringes [apodisation] of spectral rays without using filters. B. Dossier and P. Jacquinot. *J. Rech. Cent. Nat. Rech. Sci.* (*No.* 12) 123–38 (1950) *In French.*

The mathematical theory of the effect is given both for the "virtual" case when small-angle prisms are used, and for the "real" redistribution of the light by interference. The brightnesses of these systems vary inversely as the apodization, and the product of the two is generally less than the one obtained when filters are used. Graphs, tables and photographs showing the effect of the prisms are given. R. A. WEALE

535.43

7920. Influence of the electric field on the state of polarization of the Tyndall radiation. Z. László. *Hungar. Acta Phys.*, **1** (*No.* 6) 14–21 (1950) *In German.*

After reference to previous work by other workers an experimental arrangement is described in which changes of intensity and of the depolarization factor of the Tyndall light from waxes and fatty acids are measured. Some results are tabulated and a graph of variation of depolarization factor with electric field strength is shown. A theoretical explanation is given. H. G. JERRARD

535.514 : 535.39

7921. Polarimetric applications of thin films. F. Abelès. *J. Phys. Radium*, **11**, 403–6 (*July*, 1950) *In French.*

A thin transparent film on glass is used in order to get reflecting or transmitting polarizers. The former case is analogous to Brewster's reflection. One can get a very luminous and almost achromatic polarizer by using a high index film. In the latter case a device similar to the pile of plates is used. Two plates of glass covered with TiO_2 on both sides give a degree of polarization of 99·7%. A.

535.55

7922. Stress-birefringence in polystyrene. H. Kolsky. Letter in *Nature, Lond.*, **166**, 235–6 (*Aug.* 5, 1950).

535.55 : 531.259

7923. The determination of the principal stress differences at a point in a three dimensional photo-elastic model. H. T. Jessop and M. K. Wells. *Brit. J. Appl. Phys.*, **1**, 184–9 (*July*, 1950).

A method is described of finding the directions of the principal axes of stress at any point of a thin slice cut from a "frozen stress" model. The paper includes an account of the method of recording results by a stereographic projection, and a description of the universal tilting microscope stage with a brief investigation into the theory of its use. A.

535.56 : 539.132

7924. The molecular anisotropy of natural rotatory power. I–V. M. Lévy. *Ann. Phys., Paris*, **5**, 153–256 (*March–April*, 1950) *In French.*

I. A detailed quantum-theoretical exposition shows that the optical rotatory power of an individual molecule, as distinct from a random mixture, can only exist in the absence of symmetry elements of the second kind, and is independent of the sense of propagation of the light and of the orientation of its plane of polarization for a given direction of propagation relative to the molecule. Further it is shown that an "ellipsoid of gyration" fixed in the co-ordinate system of the light propagation does not in general exist but that an ellipsoid of gyration analogous to a polarizability ellipsoid, bound to the molecular co-ordinates does exist. II. A similar consideration of the action of electric and magnetic fields on the rotatory power of isotropic media shows that, in the absence of a permanent electric or magnetic dipole, an observable effect is not to be expected above 10^{-3} °K and below this only for anisotropic molecules. For paramagnetic molecules with moment μ, and a longitudinal magnetic field H (i.e. parallel to the direction of the light beam) the fractional change of the natural rotatory power ρ is given by $\Delta\rho_n/\rho_n = \frac{1}{30}\pi_{ab}(\mu H/kT)^2$ where π_{ab} is of the order of unity and is related to the electric and magnetic moment matrix elements for the transition $a \rightarrow b$ involved. For transverse magnetic fields a related formula also involves the angle between the plane of polarization of the light and the static magnetic field. In both cases the effect should be observable below 40°K in favourable molecules. At high field strengths a saturation effect occurs. III. An experimental study of cholesteryl oleate in its cholesteric mesomorphic or liquid crystal range 37–42°C shows the rotatory power to increase up to 15°/mm at 38°C with falling temperature. The ellipticity of the transmitted light due to circular dichroism behaves similarly. Reversal of a magnetic field when present reverses ρ_m the magnetic rotation of the Faraday effect and enables it to be distinguished from the contribution of ρ_n which does not reverse. The change of ρ_n, $\Delta\rho_n$, in a longitudinal field is zero at 42°C increasing to a maximum of 5°/mm at 41°C at 24 600 gauss and falling to a temperature independent value of 4°/mm from 37–40°C with light of 5 460 Å. $\Delta\rho_n$ is proportional to H^2. ρ_m shows a temperature dependence similar to $\Delta\rho_n$ but is not proportional to H and so Verdet's law is violated. Transverse fields give qualitatively similar results and variation of $\Delta\rho_n$ with the angle between the field and the plane of polarization of the light is observed as are saturation effects above 20 000 gauss. IV. The rotation of $NiSO_4 . 6H_2O$ as $T \rightarrow 0$°K is shown to reach a limiting value dependent on the light wavelength. At 1·63°K $\Delta\rho_n$ shows a maximum with longitudinal H at 15 000 gauss, which moves to higher field strengths at higher temperatures up to 20°K. $\Delta\rho_n$ is of the opposite sign in transverse fields and varies with the orientation of the plane of polarization, the light being along the axis of the crystal in all cases. V. The variation of ρ for sodium potassium tartrate hexahydrate (Rochelle salt) in its ferro-electric range +20 to −20°C is greatest at 0°C while the ellipticity shows +ve and −ve deviations from its end values in this range. $\Delta\rho$ on the application of a longitudinal electric field has a maximum of the order of 1°/mm with temperature at 0°C and a maximum with frequency of about 15 c/s for the square wave applied field. Saturation occurs above 100 V/cm for 15 c/s and at higher fields for other frequencies. The value of $\Delta\rho$ at saturation is independent of electric field frequency. Mathematical details are given for I and II and full experimental details for III, IV and V. D. H. WHIFFEN

535.56 : 539.132

7925. The molecular anisotropy of natural rotatory power. VI–VIII. M. LÉVY. *Ann. Phys., Paris*, **5**, 310–78 (*May–June*, 1950) *In French.*

VI. A theoretical treatment based on a helical model of the units of the cholesteric state is developed and applied to the results of III [see preceding Abstr.). A parameter describing the helix is derived from the frequency of absorption describing the rotatory dispersion and from the numerical value of the rotation, with concordant results at each temperature. When a magnetic field is present the theory explains the dependence of $\Delta\rho_n$ with temperature, and with the field direction in the transverse case, with very satisfactory numerical agreement. The molecules are assumed diamagnetic and their natural rotatory power is neglected. The effect of external electric fields is predicted. VII. To explain the results in IV it is necessary to assume that the magnetic field not only affects the relative populations of the spin triplet levels of the ground electronic state of Ni^{++} but also distorts the crystal structure. A distortion parameter is evaluated from the max. of $\Delta\rho_n$ and is used to calculate $\Delta\rho_n$ at other field strengths with good agreement at all wavelengths, temperatures and angles of the transverse field. VIII. Based on an internal field theory of ferro-electricity the variation of ρ with T for Rochelle salt is calculated in agreement with part V, but the action of an external electric field is too complicated to manage. Finally the present position and future possibilities are summarized.

D. H. WHIFFEN

535.56 : 539.133

7926. The theory of polarizability and circular dichroism. M. V. VOLKENSHTEĬN. *Dokl. Akad. Nauk, SSSR*, **71** (*No.* 4) 643–6 (1950) *In Russian.*

Reference is made to a previous paper [Abstr. 5754 (1950)]. It is demonstrated that the theory of polarizability sufficiently explains the dispersion of optical activity and the circular dichroism.

F. LACHMAN

535.568

7927. Applications of polarimetry to infra-red and micro-wave spectroscopy. A. KASTLER. Letter in *Nature, Lond.*, **166**, 113 (*July* 15, 1950).

Suggests that dichroism might just be detectable in the infrared near Raman-active frequencies, and in the microwave region near rotation frequencies, in the presence of static electric fields. D. H. WHIFFEN

535.6 : 513.76

7928. Graphic transformation of colorimetric co-ordinates. A. BIOT. *Ann. Soc. Sci. Brux.*, **64** (*No.* 1–2) 115–9 (1950) *In French.*

The most common requirement is to transform from a system dependent on one particular instrument into the international system. It is shown that in the XYZ triangle, representing the international system, there can be drawn a set of graduated straight lines which give the co-ordinates of a given colour in terms of its co-ordinates on the instrumental system. An algebraic and a geometrical method are given, either of which can be simply carried out when the 3 basic international colours are known in terms of the instrumental system. N. CORCORAN

535.642

7929. The calculation of tristimulus values of subtractive colour-mixtures by the method of separating grey. E. HELLMIG. *Z. wiss. Photogr.*, **45** (*No.* 4–6) 67–84 (1950) *In German.*

A mathematical analysis is given for the above purpose when the concentrations of the dyes present in the mixture are known. For the most important component colours the method yields positions differing from the corresponding places in the CIE diagram by not more than a few thousandths provided the separable "grey density" does not exceed unity. Graphs, tables and practical examples are given.

R. A. WEALE

535.65

7930. New automatic colorimeter for cotton. D. NICKERSON, R. S. HUNTER AND M. G. POWELL. *J. Opt. Soc. Amer.*, **40**, 446–9 (*July*, 1950).

This new instrument for measuring the colour of cotton is based on a satisfactory application of the Hunter Color and Color-Difference Meter to problems of raw cotton measurement. It is designed to be fully automatic and self-standardizing, and graphically to show values for reflectance (R_d) and yellowness ($+b$) on a 2-dimensional chart. It is self-contained in a movable cabinet, with a minimum of exposed parts. Although this particular model is limited to measurements in the range of cotton colour, the principles on which it is designed are adaptable to other limited ranges of colour, in either 2 or 3 dimensions, thus providing an automatic, self-standardizing small-difference colorimeter for other limited ranges of colour. A.

535.65 : 612.843.3

7931. A color saturation threshold meter. H. HABER AND H. FLECK. *J. Opt. Soc. Amer.*, **40**, 459–61 (*July*, 1950).

A meter has been designed in which a gradually changeable mixture of white and coloured light is produced. The variability of the mixture is produced by means of double refraction. A ray of white light is split into 2 beams; one traversing a colour filter. The 2 rays are then reunited so that a homogeneous mixture of white and coloured light is obtained. Polarization of the 2 rays involved permits a measurable change in the ratio of luminances of both lights between limits of zero and infinity. The instrument works satisfactorily in its present state. Yet, it could be rendered more useful by the following 2 devices which can easily be installed: (1) instead of coloured filters, interference filters producing an approach to spectrally homogeneous light can be installed; (2) application of neutral density filters of proper dimensions would provide constancy of the mixture's luminance throughout the measuring range; a condition which is only approximated for a limited range in the present instrument. A.

535.683

7932. On measurements of fastness to light of dyes and pigments. H. E. J. NEUGEBAUER. *Z. wiss. Photogr.*, **45** (*No.* 4–6) 84–94 (1950) *In German.*

An extension of work by Dossmann [*Angew. Chemie B*, **20**, 232 (1948)] on the estimation of fastness by calculation from the spectral reflection curves of

pigments before and after exposure to light. Using the curves for 8 blues of graded fastness dyed on wool, the author modified Dossmann's calculations by introducing the relative spectral luminance, and determined (1) chromaticity co-ordinates of the samples and their shifts (a) with different times of exposure (t); (2) the corresponding changes in luminance; (3) the changes (D) in the area under the spectral reflection curve in the visible region, with all changes reckoned as positive; (4) the net increase of area for the case of one pigment. A McAdam uniform chromaticity chart was used to give a in min. perceptible colour differences. Curves of the 4 functions against t show large differences in shape but (1) appears to agree best with subjective estimates of fastness. The functions D/t and D/tF_a, where F_a is the area under the spectral curve of the unexposed sample, also give reasonable indications of fastness though D is independent of spectral visual sensitivity. None of the theoretical methods is sufficiently free from objection to supersede the subjective method.

S. T. HENDERSON

535.8

7933. Calibration of precision airplane mapping cameras. F. E. WASHER AND F. A. CASE. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 1–16 (*July*, 1950).

An instrument is described that permits the registration of all the information necessary to calibrate a precision airplane camera on a single negative. Twenty-five collimators arranged at 7·5° intervals along two meridians at right angles provide optically distant targets. These targets are photographed by means of the camera to be tested. Measurements made on the negative yield information on the equivalent focal length, distortion, resolving power, prism effect, orientation of the lines joining opposite pairs of collimation index markers and location of the principal point. A brief account of the calibration of a typical camera and a discussion of the physical significance of calibrated focal length are given. A.

535.8

7934. Use of plastics in the Fresnel rhomb. G. A. HARLE. Letter in *Nature, Lond.*, **166**, 149-50 (*July* 22, 1950).

535.81 : 535.33.072

7935. Some high speed spectrograph objectives. D. H. RANK. *J. Opt. Soc. Amer.*, **40**, 462–4 (*July*, 1950).

Conditions are given for the performance requirements for a high speed spectrograph objective to be used primarily for the Raman effect in the region 4 358 to 5 000 Å. A formula is given for the construction of such an objective at a speed of $f/2·0$. This objective has a flat tangential field and gives extremely sharp definition. With slight retouching of the back of the second flint component perfection of definition can be achieved in lenses up to 12 in focal length. A correction to the formula is given to render the field flat with all spherical surfaces. The unretouched system works perfectly satisfactorily up to an 8 in focal length. The trigonometrically calculated aberration curves are given for a lens of 10 in focal length. The formula is given for construction of a 10 in focal length $f/3·5$ three-element lens. The design consists of a telescope objecti followed by an aplanatic element. Aberration a performance characteristics are given and discusse

535.8

7936. A unit for transforming the numerical apertu of a microscope objective. M. FRANÇON AND NOMARSKI. *C.R. Acad. Sci., Paris*, **230**, 2166 (*June* 19, 1950) *In French.*

This unit is placed between the object and the usu objective of the microscope. It is an aplana system, multiplying the numerical aperture of t dry objective by a factor equal to the refractive ind of the immersion liquid used, and at the same tim magnifying the object by the same factor. Co structional details of two possible systems are give R. W. FIS

535.824

7937. A new series of microscope objectives. I Preliminary investigation of catadioptric Schwarzschil systems. D. S. GREY. *J. Opt. Soc. Amer.*, 3 723–8 (*Sept.*, 1949).

This paper presents a preliminary study of combi ing the Schwarzschild pair of mirrors with lenses c fused quartz and fluorite to obtain an ultraviol microscope objective. It is found that the catadioptri Schwarzschild objective is superior to the catadioptri Newtonian objectives described in Abstr. 830 (1950) An objective using spherical surfaces and correcte from 220 mμ into the near infrared is described. Th obscuring ratio of this objective is 7% in area a NA 1·1. A

535.824

7938. A new series of microscope objectives. III Ultraviolet objectives of intermediate numerica aperture. D. S. GREY. *J. Opt. Soc. Amer.*, 40 283–90 (*May*, 1950).

Paper II [preceding Abstr.] demonstrates tha spherical lens elements combined with spherica mirrors may provide well-corrected and achromatize ultraviolet microscope objectives. The present pape presents a further study of several types of catadioptri Schwarzschild systems which provide microscope objectives relatively easy to construct, convenient t use, and for which ultraviolet and visual range performance characteristics are not compromised Several modifications with numerical apertures within the range 0·4 to 1·0 are presented. A

HEAT 536

536.1

7939. Concepts of resistance, capacitance and inductance in thermal circuits. R. C. L. BOSWORTH. *J. Proc. Roy. Soc., N.S.W.*, **82** (*No.* 3) 211–17 (1948).

The analogy between heat and electrical flow leading to the concepts of thermal resistance and capacitance is well known. Considerations of thermal circuits which involve natural convection in fluids leads to the idea of thermal inductance. Experiments showing these effects are described and the results are shown graphically. The units of thermal

resistance, capacitance and inductance are then derived thermodynamically. E. H. DOCK

536.2

7940. Measurement of thermal conductivity to — 180°C. C. CODEGONE. *Ric. Sci.*, **20**, 68–70 (*Jan.–Feb.*, 1950) *In Italian.*

An extension to still lower temperatures of the method previously described [Abstr. 2130 (1947)]. Liquid oxygen is used in place of solid CO_2. Results for silica gel, vermiculite, Mg carbonate and "lana di scorie" of densities 820, 90, 220 and 250 kg/m³ over the range 20 to — 180°C are shown graphically. S. WEINTROUB

536.2

7941. Thermal equilibrium of a porous plate cooled by the injection of a cold fluid. J. BERGER. *C.R. Acad. Sci., Paris*, **230**, 1935–7 (*May* 31, 1950) *In French.*

This problem, the plate receiving heat at a constant rate on one side, is discussed mathematically in general terms. As a numerical example the case of a Cu plate cooled with air initially at 0°C is considered; the distribution of temperature in the plate, the difference in temperature of metal and gas, the effect of varying porosity and of size of holes are shown graphically. F. E. HOARE

536.413.2

7942. On the variation of the coefficient of expansion of glass at low temperature. A. WINTER-KLEIN. *C.R. Acad. Sci., Paris*, **230**, 1857–8 (*May* 22, 1950) *In French.*

The results, shown graphically, obtained with a recording differential dilatometer, of the variation with temperature of the expansion of a boro-silicate crown and a flint glass show the existence of a second region, in addition to the well-known transformation region, where the coefficient of expansion is discontinuous. S. WEINTROUB

536.42

7943. Mathematical decomposition of the total vapour pressure curves into partial pressure curves. II. New methods and their practical application. A. MUSIL AND E. SCHRAMKE. *Acta Phys. Austriaca*, **3**, (*No.* 4) 309–19 (1950) *In German.*

For I see Abstr. 3116 (1950). A strict mathematical method of resolving the total vapour pressure curve into the partial pressure curves of the components, and a simpler modification of the method, are given. A. J. MEE

536.421.4

7944. On the freezing of water droplets at about — 41°C. C. LAFARGUE. *C.R. Acad. Sci., Paris*, **230**, 2022–4 (*June* 5, 1950) *In French.*

It is shown that the formation of small ice crystals at — 41°C is not due to foreign nuclei such as those produced in the atmosphere by u.v. radiation, nor to saline nuclei in the case of solutions, but occurs spontaneously as a result of the molecular structure of the water below 4°C. It is stated that this is in accord with previous experimental work. T. C. TOYE

536.422.1

7945. Evaporation and mobility of naphthalene molecules. V. J. CLANCEY. Letter in *Nature, Lond.*, **166**, 275 (*Aug.* 12, 1950).

536.423.1

7946. The problem of the influence of pressure on the mechanism of evaporation in a boiling liquid. L. M. ZYSINA-MOLOZHEN AND S. S. KUTATELADZE. *J. Tech. Phys., USSR*, **20** (*No.* 1) 110–16 (1950) *In Russian.*

A critical reconsideration of the old theory, whose results are at variance with modern conceptions and experimental data, if the pressure is other than atmospheric. The equation of motion of the liquid with respect to the heated surface, the equation of motion of steam bubbles, the heat propagation in the liquid and the heat exchange at the surface of separation of the phases must be taken into account. The determination of the bubble size in a boiling liquid, by aid of slow-motion cine-pictures (1 000 exposures/sec) is followed by grapho-analytical evaluation. B. K. KRAUS

536.423.15

7947. The vapour pressure of liquid carbon dioxide. A. MICHELS, T. WASSENAAR, T. ZWIETERING AND P. SMITS. *Physica*, **16**, 501–4 (*May*, 1950).

The vapour pressure of CO_2 has been measured between — 56°C and + 3°C. The results are described by a semi-empirical formula. Special attention has been paid to the vapour pressure at 0°C. A.

536.423.15

7948. The vapor pressure of Americium. N. D. ERWAY AND O. C. SIMPSON. *J. Chem. Phys.*, **18**, 953–7 (*July*, 1950).

The vapour pressure of Am from a dilute solution in Pu has been measured by a modification of the Knudsen effusion method. The resulting vapour pressure for pure Am in the temperature range 1 450°K to 1 820°K is given by the equation $\log_{10} p_{mm} = 7{\cdot}02 - (11\,300)/T$. The vapour pressures are probably accurate to a factor of 2 or 3. Relative values are much more precise. A.

536.46

7949. Theory of ignition limits and ignition of combustible gas mixtures. K. BECHERT. *Ann. Phys., Lpz.*, **7** (*No.* 3–4) 113–28 (1950) *In German.*

The fundamental assumption is made that if the gas contained within a sphere of radius r is brought to the temp. and density of the reacted products in a steady flame, then a steady flame will propagate itself through the main body of gas only if r is several times greater than Δx, the thickness of the steady flame front. Quantitative estimates of ignition limits are based on the arbitrarily chosen condition that for $r \geqslant 10\Delta x$ ignition will result. Values of Δx used are obtained from previous papers [Abstr. 4921 (1950)]. In the case of spark ignition, which is examined in detail, r is taken as equal in order of magnitude to the spark gap interelectrode distance L. The voltage V required to break down a gap of length L may be evaluated theoretically, and hence, using the relation $L = r \geqslant 10\Delta x$, the voltage V required for ignition can be obtained. The capacity K of the condenser producing the spark is of little importance, as K affects mainly the spark radius, which is generally $\ll L$. Comparison of the theory

with experimental results shows good quantitative agreement, except for fuel-rich mixtures.

A. SCHOFIELD

536.46

7950. Fire protection precautions for uranium scrap and powder. E. J. KEHOE, F. L. BRANNIGAN AND M. EISENBUD. *Nucleonics*, **6**, 34–37 (*May*, 1950).

Uranium metal in the finely divided form may ignite spontaneously on contact with air. Safe procedures for storage, handling shipment and disposal are outlined and methods of dealing with U scrap fires are reviewed. L. R. SHEPHERD

536.46

7951. Reflections on the combustion of pulverized fuels. G. MONNOT AND R. VICHNIEVSKY. *C.R. Acad. Sci., Paris*, **230**, 2079–80 (*June* 12, 1950) *In French.*

Photoelectric pyrometry shows that the colour temp. of the flame in a Diesel engine at the ignition point is approx. 1 950°K over a wide range of operating conditions. The max. flame temp, in an experimental oil-fired furnace was found to be between 1 800°K and 1 850°K; this temp., too, is almost independent of operating conditions. It is suggested that the constancy of temp. may be explained by the following mechanism of combustion. Each droplet of fuel burns radially inwards, the flame passing through regions successively richer in fuel until it reaches the upper limit of combustion; from this point on, further propagation is by diffusion of fuel outwards and air inwards to maintain the composition at the upper limit. The flame temps. in the Diesel engine and the experimental furnace are consistent with burning at the upper limit of combustion.

A. SCHOFIELD

536.48

7952. Review of the properties of liquid He II. J. H. MELLINK. *Ned. T. Natuurkde*, **16**, 66–78 (*April*, 1950) *In Dutch.*

536.48

7953. The two-fluid model. C. J. GORTER. *Ned. T. Natuurkde*, **16**, 79–86 (*April*, 1950) *In Dutch.*

See Abstr. 6163 (1949), 230 (1950).

536.48

7954. The phenomenological theory of liquid helium II. S. NAKAJIMA, K. TOMITA AND T. USUI. *Phys. Rev.*, **78**, 768–79 (*June* 15, 1950).

The purpose of the present paper is to refine the "2-fluid model" as a phenomenological theory of liquid He II. General thermohydrodynamical equations are formulated, following the treatment of viscous fluids by Eckart and Tolman. Previous phenomenological theories are included in the present general formalism, and their intrinsic relations are discussed from a unified point of view. The thermodynamic equations of motion are then applied to the stationary flow in He II under the reversible process approximation. Adopting Gorter's type of mutual friction, we can fully describe the fountain pressure (thermomechanical effect) and the anomalous heat transfer (heat-superconductivity). The theoretical predictions concerning the maximum fountain pressure or maximum heat current against temperature, and the critical current appointing the validity limit of H. London's thermostatical relation $dp/dT = \rho s$, are fairly consistent with observed tendencies. A.

536.48

7955. Lambda-temperatures of solutions of He^3 in He^4 below 1°K. J. G. DAUNT AND C. V. HEER. *Phys. Rev.*, **79**, 46–51 (*July* 1, 1950).

Measurements have been made of the transition (lambda) temperatures at which solutions of He^3 in He^4 first show superfluidity by observation of the thermal isolation of a vessel which contained the solutions and which was cooled to low temperatures by a paramagnetic salt. The incidence of superfluidity was accompanied by a high heat influx to the solution produced by a convection of film flow to the high temperature together with return flow in the vapour phase. The solution with the highest concentration, namely 89% He^3, had a lambda-temperature of 0·38°K; solutions with smaller He^3 content (concentrations down to 42% He^3 were investigated) showed higher lambda-temperatures ranging up to 1·15°K. It was concluded that pure He^3 could not be superfluid above 0·25°K and most probably is not superfluid down to 0°K. From the results conclusions have been drawn regarding the free energy of pure He^4 in the liquid II state on the basis of the 2 fluid model. A.

536.48

7956. The rotation of liquid helium II. D. V. OSBORNE. *Proc. Phys. Soc., Lond. A*, **63**, 909–12 (*Aug.*, 1950).

An experiment is described in which the free surface of rotating liquid helium II is studied. It is shown that the results, which are the same as for any ordinary liquid, are not in accordance with the hypothesis that the superfluid component remains stationary. On this basis an estimate of the critical velocity for superfluidity is made and is compared with previous determinations. A.

536.48 : 534.613

7957. Observation of second sound radiation pressure by the thermal Pitot tube. J. R. PELLAM. Letter in *Phys. Rev.*, **78**, 818 (*June* 15, 1950).

536.48 : 541.126

7958. Some experiments on the explosive reaction between liquid oxygen and acetylene. Y. NOMURA AND E. KANDA. *Sci. Rep. Res. Inst. Tohuko Univ., Ser. A*, **1**, 33–5 (*May*, 1949).

It has been suggested that the probable cause of explosions during the separation of liquid O_2 from liquid air is either decomposition of copper acetylide impurities or an explosive reaction between acetylene and ozone contaminating the liquid air. Experiments are described which show that no explosion occurs when acetylene is passed into pure liquid O_2 or into pure liquid O_2 containing a suspension of fine copper powder, but that explosions do occur when acetylene and ozone are brought together at the temp. of boiling liquid air. The formation of O_3 in the air liquefaction process is thought to be attributable to electrical discharges between particles of ice, frozen oil, or CO_2 which acquire a charge by friction during their passage through the reducing valves.

A. SCHOFIELD

536.48 : 541.183

7959. Investigations on the adsorption of helium at very low temperatures. H. P. R. Frederikse and C. J. Gorter. *Physica*, **16**, 402–18 (*April*, 1950).

Adsorption isotherms of helium have been measured on 2 adsorbents, jewellers rouge and steel, the temperatures ranging from 1·3°K to 2·3°K. The isotherms are sigmoid-shaped and only slight differences exist between adsorption on an apparently flat surface and on a porous substance. The results are discussed with the aid of the Brunauer–Emmett–Teller theory. A comparison of the unimolecular covering of different adsorbates shows that the number of He molecules adsorbed in the first layer is about 4 times higher than the number of N, O or A molecules. This seems to be connected with the high compressibility and the zero-point motion of the condensed He. Finally a few values of the differential Gibbs functions, entropies and heats of adsorption are derived from the results on He. A.

536.53 : 537.58

7960. The use of spontaneous voltage fluctuations for the measurement of low temperatures. P. M. Endt. *Physica*, **16**, 481–5 (*May*, 1950).

A discussion is given of the method proposed by Lawson and Long [Abstr. 3146 (1946)] to use the noise across a resistance as a measure of its absolute temperature. The statistical fluctuations in the measured noise are calculated, taking into account the bandwidth of the amplifier. This calculation shows that is not necessary to use a first tube with lowered voltages on plate, screengrid and heater and it shows that a quartz crystal is essentially worse than a pure resistance or a $L - C$ circuit as a thermal noise generator for thermometrical purposes. A.

536.532

7961. The response of thermocouples to rapid gas-temperature changes. M. W. Carbon, H. J. Kutsch and G. A. Hawkins. *Trans. Amer. Soc. Mech. Engrs*, **72**, 655–7 (*July*, 1950).

This paper presents practical data which were taken from the main results of a research programme dealing with the response of thermocouples to changing gas temperatures. Experimental and theoretical data for the response time of thermocouples ranging in wire size from 0·01 to 0·0005 in are presented. The experiments were performed over a range of temperatures from 70°F to 950°F, and for air velocities ranging from 0 to 125 fps. All of the experiments were carried out in such a way that the hot junction of the thermocouple was always cooled. An equation is presented for computing the response time for thermocouples fabricated from fine wires and subjected to sudden air-temperature changes. Heat transfer by conduction and radiation were negligible in the experiments performed. A.

536.632

7962. Heat capacity of sodium between 0° and 900° C, the triple point and heat of fusion. D. C. Ginnings, T. B. Douglas and A. F. Ball. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 23–33 (*July*, 1950).

Using an improved ice calorimeter and furnace, the enthalpy changes of two samples of pure Na have been accurately measured by a drop method at a number of temperatures between 0° and 900°C. Equations are derived to fit the data, and values of enthalpy and entropy, based on zero values at 0°C, and heat capacity are tabulated for both solid and liquid. Sources of significant experimental error are examined critically, and some theoretical implications of the results are discussed qualitatively. A.

THERMODYNAMICS 536.7/.8

536.7

7963. On the foundations of the thermodynamics of irreversible processes. H. Müller. *Ann. Phys., Lpz.*, **7** (*No.* 1–2) 73–80 (1950) *In German.*

The two principles of thermodynamics, the energy and entropy laws, are insufficient for characteristic irreversible processes, the latter having a qualitative character only. For such processes another principle is required which in combination with the others shall form a satisfactory foundation for a general theory of irreversible transformations. The possibility of formulating such a principle arises from the requirement that the energy distribution in the stationary state shall be the smoothest in the sense of an application of Dirichlet's principle. It can be shown that this requirement in combination with the fundamental principles determines the stationary state and the manner in which this is reached from a given initial state. F. E. HOARE

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.122 : 538.3

7964. The angular momentum of the electron in classical electrodynamics. F. A. Kaempffer. *Canad. J. Res. A*, **28**, 336–8 (*May*, 1950).

It is shown that not only the rest-mass of the electron but its spin as well is carried by the surrounding electromagnetic field. The ratio of magnetic moment and angular momentum (g-factor) of the electron is determined. The law of conservation of angular momentum is checked. A.

ELECTROSTATICS . DIELECTRICS 537.2

537.212 : 621.3.013

7965. Calculation of a given electrostatic field by means of conformal transformations. J. P. Schouten and H. W. F. van't Groenewout. *Ingenieur*, **62**, E9–E10 (*Aug.* 9, 1950).

537.222

7966. Electrets. W. F. G. Swann. Letter in *Phys. Rev.*, **78**, 811–12 (*June* 15, 1950).

A one-dimensional mathematical treatment of the

problem of charge storage by electrets is given, assuming that electrets consist of (*a*) a distribution of semi-permanent polarization which changes with time, and (*b*) a distribution of surface and volume charge which disappears according to ohmic conductivity, and has no relation to the decay of the polarization. C. A. HOGARTH

537.226.1

7967. Influence of dipole–dipole coupling on the dielectric constant of dipolar substances. A. A. SABRY. *Proc. Phys. Soc., Lond. A*, **63**, 716–26 (*July*, 1950).

Kirkwood's formula for dielectric constant, ε, gives it in terms of a correlation coefficient which depends on the probability that any 2 dipolar molecules have a certain configuration. Calculation of the configurational probability of the dipole orientations is dealt with by considering 2 dipoles and replacing the rest by a homogeneous dielectric. The dipolar molecules are regarded as point dipoles and the effect of other forces on the orientation of the molecules is neglected. The calculation of the correlation coefficient appearing in Kirkwood's dielectric constant formula is then carried out. This correlation coefficient is evaluated for water, and the value of ε then obtained from Kirkwood's formula is in fair agreement with the observed value. A.

537.226.1 : 537.228.4 : 538.612

7968. The phenomena of molecular orientation in polar liquids and their solutions. I. Extension of Onsager's theory. A. PIEKARA. *Acta Phys. Polon.*, **10** (*No.* 1–2) 37–68 (1950).

Defects in Onsager's dielectric theory, due to neglect of specific interaction between neighbour molecules, are shown up by the detailed interpretation of experimental data on the dielectric constant, on the electric saturation and on the Kerr effect, for solutions of nitrobenzene in benzene. Aggregation of nitrobenzene in antiparallel pairs explains the discrepancies and also the details of the Cotton–Mouton effect measurements. D. H. WHIFFEN

537.226.2

7969. The dielectric constant of water at high temperatures and in equilibrium with its vapor. G. C. AKERLOF AND H. I. OSHRY. *J. Amer. Chem. Soc.*, **72**, 2844–7 (*July*, 1950).

The constant was determined in the temperature range from the normal boiling to the critical point. The data obtained may be expressed by the equation

$$D = 5\,321/T + 233{\cdot}76 - 0{\cdot}9297T + 0{\cdot}001417T^2 - 0{\cdot}0_6 8292T^3$$

(T = abs. temp.) A.

537.226.2

7970. Dielectric constants of methyl alcohol–benzene mixtures. J. H. LAROCHELLE AND A. A. VERNON. Note in *J. Amer. Chem. Soc.*, **72**, 3293–4 (*July*, 1950).

537.226.2 : 621.3.011.5

7971. Electrical constants of sand at ultra high frequencies. S. K. CHATTERJEE. *Indian J. Phys.*, **24**, 143–50 (*April*, 1950).

Electrical constants of dry and moist sand (up to 5% moisture content) have been measured over a frequency range of 300 Mc/s to 500 Mc/s. Dielectric constant, conductivity and loss tangent increase with increasing moisture content. Dielectric constant and conductivity of dry sand vary between 2·6 to 2·7 and $0{\cdot}26\times10^8$ e.s.u. to $1{\cdot}04\times10^8$ e.s.u. respectively over the frequency range in question. Loss tangent for dry sand varies from 64×10^{-3} to 153×10^{-3} over the same frequency range. Reflection coefficient for dry sand remains practically constant at 0·24 over 300 Mc/s to 500 Mc/s. But phase change on reflection varies with frequency. Reflection coefficient increases from 0·24 to 0·35 at 500 Mc/s for dry sand to 5·6% moist sand. There occurs also a variation of phase change on reflection with different moisture content. A.

537.226.32

7972. The Lorentz correction in barium titanate. J. C. SLATER. *Phys. Rev.*, **78**, 748–61 (*June* 15, 1950).

It is assumed, following Devonshire, that the ferroelectric behaviour of $BaTiO_3$ arises because of the Lorentz correction, leading to a vanishing term in the denominator of the expression for dielectric constant. If the polarizability varies slowly with temperature, the temperature variation of dielectric constant follows. This temperature variation is assumed to come from that part of the polarization resulting from the displacement of the Ti ion, in a field whose potential energy has 4th-power as well as 2nd-power terms in the displacement. The main object of this paper is to compute the Lorentz correction exactly, not assuming spherical symmetry, but taking account of the precise crystal structure. When this is done, it is found that the Ti ions, and those O ions which are in the same line with them, the line being parallel to the electric field, exert very strong fields on each other, the resulting local field at the Ti ion being much greater than if computed on the assumption of spherical symmetry. This enhanced field makes it clear that even a relatively small ionic polarizability for the Ti ions will be enough to lead to ferroelectricity. The polarization of the Ti ions is however an essential feature of the theory; if they are not polarized, the Lorentz correction is profoundly modified, leading almost exactly to the value given by the approximate theory assuming spherical symmetry, and not resulting in ferroelectricity. Detailed formulae are given for comparison of the present theory with Devonshire's results, so that the present methods can be incorporated in his treatment of the effect of elastic strain energy on the stability of the various phases below the Curie point. A.

537.226.8 : 548.0

7973. Effect of pressure on the low frequency dielectric constant of ionic crystals. S. MAYBURG. *Phys. Rev.*, **79**, 375–82 (*July* 15, 1950).

Data on the pressure dependence of the dielectric constant ε of MgO, LiF, NaCl, KCl and KBr at 1 000 c.p.s. and room temperature are given as a function of hydrostatic pressure from 0 to 8 000 bars. The dielectric constants are found to decrease with an initial slope $(\partial \ln\varepsilon/\partial p)_T$ ranging from $-0{\cdot}32\times10^{-5}$ bar^{-1} in the case of MgO to $-1{\cdot}17\times10^{-5}$ bar^{-1} in the case of KBr. Present lattice theories are only

capable of explaining these data if the inner field decreases with increasing pressure. A.

537.228.4

7974. The operation and photographic characteristics of a Kerr-cell type of electro-optical shutter. A. E. J. HOLTHAM AND H. A. PRIME. *Proc. Phys. Soc., Lond. B*, **63**, 561–72 (*Aug.*, 1950).

A Kerr-cell electro-optical shutter is described, the shutter action being controlled by a high-voltage pulse applied to the cell electrodes. The exposure time used is 2×10^{-6} sec, and provision is made for obtaining "delayed" exposures up to times of the order of 10^{-4} sec. The photographic limitations of the shutter are discussed and the formation of the image considered in some detail. The assumptions necessary for a quantitative photometric analysis of Kerr-cell exposures are stated and an approximate limit is set on the magnitude of errors resulting from such assumptions. The applications of the Kerr-cell technique to the measurement of particular spark channel characteristics are also described. A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 530.162

The statistical analysis of electrical noise. *See Abstr.* 7753

537.311.1

7975. The Bloch integral equation and electrical conductivity. P. RHODES. *Proc. Roy. Soc., A*, **202**, 466–84 (*Aug.* 22, 1950).

An account of the solution, for effectively the whole temperature range, of the Bloch integral equation for the electron momentum distribution in a metal in an electric field. Solutions of this equation, from which the temperature variation of the electrical conductivity of the metal may be immediately calculated, have previously been obtained only in the limiting cases of "high- and low-temperatures," corresponding to $(T/\theta_D) \gg 1$ and $\ll 1$, where θ_D is the Debye characteristic temperature. As a preliminary to its solution by numerical methods the integral equation is expressed in a non-dimensional form. Solutions are obtained by deriving a high-temperature approximation which is valid over a much wider temperature range than that previously known, and by means of a method of successive approximations. The temperature variation of conductivity is calculated from these solutions, and it is shown that there are significant differences between the results and those obtained from the semi-empirical formula of Grüneisen. A comparison is made between the calculated and observed temperature variation of conductivity for a number of metals. There are deviations in detail, and a brief discussion is given of secondary factors from which they may arise, but in general the agreement is good, and it is concluded that the theoretical treatment covers satisfactorily the main features of the observed variation. In an appendix it is shown that the approximate relations obtainable by the variational method developed by Kohler are consistent with the more exact results obtained here. A.

537.311.3

7976. Some measurements of the resistivity of good insulators. N. W. RAMSEY. *Proc. Phys. Soc., Lond. B*, **63**, 590–4 (*Aug.*, 1950).

Measurements of the resistivity of good insulators were carried out by measuring the loss of charge on a condenser. A knowledge of the dimensions of the insulator is not required. It was found that the insulation resistances of amber, alkathene, distrene and Perspex increase with time over a period of weeks, the final values being considerably higher than previously published figures. There is no significant difference between the values for the first three materials. The leakage time necessary for reasonable accuracy is indicated. A.

537.311.31 : 537.583 : 621.385.032.216

7977. Electrical conductivity of oxide cathode coatings. D. A. WRIGHT. *Brit. J. Appl. Phys.*, **1**, 150–3 (*June*, 1950).

Conductivity measurements on activated coatings give results similar to those of Vink and Loosjes [Abstr. 1488 (1950)]. Their theory implies Ba concentration of at least 10^{19} atoms/cm^3. Hall effect measurements indicate 10^{14} electrons/cm^3 at 1 100°K, and free path 2×10^{-5} cm. This result may not in fact be inconsistent with the Vink–Loosjes theory. P-type conductivity is not encountered in well-activated coatings, and is a feature developing while drawing emission under non-activating conditions. It is due to oxidizable impurities in the coatings. Rapid poisoning or activating effects at low temperatures emphasize the importance of phenomena at surfaces, and it is suggested that these are associated with electron or hole movement rather than ion movement. A.

537.311.31 : 539.23

7978. Current-tension ratio of very thin silver films in high intensity electric fields. A. BLANC-LAPIERRE AND M. PERROT. *C.R. Acad. Sci., Paris*, **230**, 1641–3 (*May* 8, 1950) *In French.*

Due to the discontinuous structure of very thin metallic films Ohm's law shows certain characteristic deviations at room temperature from the linear function $E = R.I.$ The films (thinner than 10 mμ) were tested in fields of up to 10 kV/cm. The results obtained are very similar to those in semi-conductors and imperfect metallic contacts in air. W. SUMMER

537.311.32

7979. Electrical resistance of thoria. W. E. DANFORTH AND F. H. MORGAN. *Phys. Rev.*, **79**, 142–4 (*July* 1, 1950).

Measurements were taken in vacuum at temperatures up to 2 073°K. Activation by passage of current resulted in values of resistance as low as 1 ohm-cm at 1 900°K and 10 ohm-cm at 1 000°K. Activation energies between 3·2 V and 0·58 V were found. The density of impurity centres was computed as 10^{18} per cm^3 and was found to be independent of the degree of activation by current, a result which is inconsistent with the hypothesis of the electrolytic origin of impurity centres. A.

537.311.33

7980. Study of the semi-conducting properties of a natural calcium carbonate. P. VIDAL. *Ann. Phys., Paris*, **5**, 257–309 (*May–June*, 1950) *In French.*

The properties of semi-conducting minerals are summarized and in particular a study of the properties of $CaCO_3$ in the form of natural chalk is described. Chalk from near the earth's surface is very impure, has a low resistance and undergoes spontaneous polarization. Chalk from a deep quarry is very pure, has a high resistance and shows no spontaneous polarization; in fact it behaves as a normal semi-conductor. The current strength for an applied voltage decreases with time to a limiting value. Ohm's law is not obeyed; for applied potentials greater than 300 V the current decreases more rapidly than the applied potential. In the limiting current region there is a sharp decrease in potential at the cathode and practically none at the anode. By adding specimens in sections and additional probe electrodes it is concluded that only the CO_3^{--} ions are mobile (apart from the motion of any carriers due to impurities). The conductivity/time curves enable the mobilities of ions to be calculated. The potential barrier at the cathode produces rectification; if the cathode is made of a metal grid, then for applied potentials greater than a certain value, about 400 V soft X-rays are emitted. The results are applicable to a geophysical survey for chalk and also to a test for the purity of chalk (spontaneous polarization).

C. A. HOGARTH

537.311.33

7981. Conductivity of microcrystalline, halogen-containing selenium. H. SCHWEICKERT. *Z. Phys.*, **128** (*No.* 1) 47–55 (1950) *In German.*

The effect of temperature treatment at 210°C on the electrical conductivity of microcrystalline Se in cylindrical rod form is studied. Addition of Se chloride or oxychloride increases the conductivity and a relation between Cl content and the value of maximum conductivity is obtained. It is found that metallic impurities decrease the conductivity.

G. F. J. GARLICK

537.311.33

7982. Temperature dependence of the energy gap in monatomic semiconductors. H. Y. FAN. Letter in *Phys. Rev.*, **78**, 808–9 (*June* 15, 1950).

537.311.33

7983. Transmutation-produced germanium semiconductors. J. W. CLELAND, K. LARK-HOROVITZ AND J. C. PIGG. Letter in *Phys. Rev.*, **78**, 814–15 (*June* 15, 1950).

537.311.33 : 535.371

Theory of luminescence and electrical conductivity of cadmium sulphide crystals. *See Abstr.* 7891

537.311.33 : 537.21

7984. Johnsen–Rahbek effect with an electronic semi-conductor. C. BALAKRISHNAN. *Brit. J. Appl. Phys.*, **1**, 211–13 (*Aug.*, 1950).

The force of attraction which appears when a potential difference is applied between a piece of metal and a piece of semi-conductor, having accurately plane surfaces in contact with one another, has been investigated. Using an electronic semi-conductor the effect does not require the presence of moisture as Johnsen and Rahbek's experiment did. The force is very roughly proportional to the square of the applied potential. A.

537.311.33 : 537.311.1

7985. Fermi levels in semiconductors. R. A. HUTNER, E. S. RITTNER AND F. K. DU PRÉ. *Philips Res. Rep.*, **5**, 188–204 (*June*, 1950).

General formulae for determining the Fermi level and the density of free charge carriers in semi-conductors are derived. Special semi-conductor models are considered in detail and a few applications are discussed. A.

537.311.33 : 537.533.9

7986. Electron bombardment induced conductivity in selenium. L. PENSAK. Letter in *Phys. Rev.*, **79**, 171–2 (*July* 1, 1950).

537.311.33 : 541.5

7987. Controlled-valency semiconductors. E. J. W. VERWEY, P. W. HAAIJMAN, F. C. ROMEIJN AND G. W. VAN OOSTERHOUT. *Philips Res. Rep.*, **5**, 173–87 (*June*, 1950).

In inorganic solids of a more or less polar type (e.g. oxides) a condition for electronic conductivity is that the lattice contains ions derived from the same element but of different valency in the same crystallographic position. A new type of semi-conductors is described in which this condition has been realized by the introduction of a fraction of ions of deviating valency without the simultaneous formation of lattice defects as in "non-stoichiometric" compounds. Such a situation is promoted by the incorporation into the lattice of foreign ions of such a charge that they balance the charge of the ions of deviating valency. Various examples are given and some of the properties of the materials thus obtained are described. Materials of this type have been applied, for instance, in ceramic resistors having a large negative temperature coefficient of the resistance. The influence of various impurities upon the specific resistance of poorly conducting substances or insulators with a crystal lattice of the polar type can also be understood along these lines. A.

537.311.33 : 621.314.63

7988. On the frequency response of PbS transistors. P. C. BANBURY AND H. K. HENISCH. Letter in *Proc. Phys. Soc., Lond. B*, **63**, 540–1 (*July*, 1950).

The frequency response of voltage gain of PbS transistors [Abstr. 6498 (1950)] is compared experimentally with that of Ge transistors, and the curves presented show a similar form for both Ge and PbS, with cut-off frequencies of the same order, under similar operating conditions. Higher collector voltages improve the voltage gain for a given frequency. A transverse magnetic field applied in a similar manner to that of Brown [Abstr. 2456 (1950)] modifies the frequency response. From the direction of the effect, it is concluded that electrons are injected into the deficit-conducting PbS. C. A. HOGARTH (R)

537.311.33 : 621.314.63 : 621.315.59

7989. Notes on the transistor and surface states in semi-conductors. N. F. MOTT. *Rep. Brit. Elect. Res. Ass.* (*Ref. L/T216*) 6 *pp.* (1949).

The Ge transistor is described and its action dis-

cussed in the light of the Mott–Schottky theory of barrier-layer rectification; with the assumptions that the height of the barrier is independent of the whisker material used, and that the height is the same as the intrinsic activation energy. Band diagrams for the energies of electrons and injected holes are given, and the problem of carrier life-times and transit times is considered. A tentative explanation of current amplification based on a simple hole multiplication process is offered. Modifications to rectifier theory caused by adoption of the concept of surface electronic states are discussed in relation to the properties of P-type Ge, Si, Cu_2O and SiC. C. A. HOGARTH (R)

537.311.33 : 621.314.63 : 621.315.59

7990. On the back current in blocking-layer rectifiers. J. H. GISOLF. *Phil. Mag.*, **41**, 754–69 (*Aug.*, 1950).

This paper is based on the theory of the metal semi-conductor contact of Schottky and of Davidov, and is meant (*a*) to make this theory applicable in practice to all existing semi-conductor types, and (*b*) to introduce quantitatively the influence of the electric field at the interface on the threshold energy. It appeared to be useful to introduce an independent variable y, proportional to the reciprocal of the concentration of the conduction electrons. A differential equation of the Abel type is derived for the electric field in the semi-conductor as a function of y. Taking into account the diminution of the threshold energy by the electric field at the interface, a relation is derived between the variable y and the electric field at the interface. The differential equation is given for the different types of semi-conductors. When the differential equation is solved, the current-voltage characteristic can be found by numerical integration. Some examples are given. In the case of back currents, an asymptotic solution of the differential equation exists, which leads to a parametric representation of the current-voltage characteristic in the back direction. The shape of the back current characteristic is discussed. The differences between rectifiers of the Se type and the crystal detectors are elucidated. Some remarks on the physical background of the electrical pretreatment of Se rectifiers are made. A.

537.311.33 : 621.315.592

7991. Semiconductors and their applications. R. W. DOUGLAS. *G.E.C. J.*, **17**, 107–24 (*July*, 1950).

The structure of solids and their classification as metals, insulators and semi-conductors is reviewed, particularly in view of the temperature variation of their properties. The properties of metal/semi-conductor contacts are discussed in terms of the Mott–Schottky theory and of Bardeen's surface states. Reference is made to recent designs of Ge and Si detectors and of Se and Cu_2O rectifiers. The functions of the three added impurities in Si crystal diodes is discussed; it is assumed that the B produces positive holes, but that the Be and Al form a surface oxide layer. The mechanism of SiC when used as a surge arrester is discussed, the rectification between two "similar" SiC crystals being thought to be due to surface levels. The action of the Ge crystal triode is discussed, and one commercial design is described. C. A. HOGARTH (R)

537.311.33 : 621.385.1.032.216 : 621.3.011.2

7992. On the resistance of interface of oxide-coated cathode. H. KAWAMURA AND A. SHINOHARA. *J. Phys. Soc. Japan*, **5**, 90–5 (*March–April*, 1950).

Two cylindrical cathodes were mounted so that coated regions were pressed together with a probe between. The VR characteristic was measured using a saw-tooth voltage. The voltage between probe and cathode was applied to one pair of oscilloscope plates and the signal on the other plates is obtained by differentiating and amplifying the same voltage. Calibration is performed by inserting a known ohmic resistance. The influence of core impurities was investigated. When the core contained reducing agents (Mg, Mn) the direction of easy flow was from core to oxide. For electrolytic Ni cores and for "A" Ni cores the direction was reversed and the value of resistance was much greater. The reversal in the first case is explained as being caused by a thin insulating layer through which the electrons pass by tunnel effect (Wilson rectification). In some cases a characteristic with a minimum in the resistance curve at $V = 0$ was found. This was thought to be due to the formation of double rectifying layers in series. The activation energy of the conductivity of the bulk oxide was 0·55 eV. A. H. W. BECK

537.311.33 : 666

7993. Electrical conduction in glass. P. L. KIRBY. *Brit. J. Appl. Phys.*, **1**, 193–202 (*Aug.*, 1950).

The mechanism of electrical conduction in glass is explained in the light of modern theories of its atomic structure, and the electrical migration of "foreign" ions is discussed. The action of the glass electrode is described and the occurrence of the alkaline error is considered from the viewpoint of atomic structure. Compositional variation of conductivity is explained by reference to the valency requirements of the network atoms, and the temperature variation of conductivity is examined. The relative magnitudes of the dielectric absorption current and true conduction current are considered, and the total loss angle calculated at varying temperatures to illustrate the change-over from a dielectric to an ionic conductor. Attention is given to the stabilization effects observed in the annealing range. The observed inflexions in the log resistivity *v.* reciprocal absolute temperature graphs are shown to arise from a different cause from those discovered in the case of ionic crystals. Note is made of certain low-temperature isothermal changes in the conductivity of glass. A.

537.312.5

7994. Concerning the theory of photoconductivity in infrared-sensitive semiconductive films. E. S. RITTNER. *Science*, **111**, 685–8 (*June* 23, 1950).

The properties of Tl_2S, PbS, PbSe and PbTe as used in infrared photo-conductive cells are summarized and reviewed in the light of the 3 relevant theories, the detailed balancing of *n*- and *p*-impurities, the random distribution of *p–n* barriers, and the "impurity semi-conductor" picture. The last possibility is ruled out. A model for the photo-conductivity, which explains most properties, particularly the part played by the O, is suggested. It is supposed that on evaporation an *n*-type semi-conductor is produced,

but that O produces *p*-type regions on the surfaces of some grains, and a random distribution of *n–p* "transition regions." As the "oxidation" proceeds further the *n*-type conducting paths become more and more disrupted by the *p*-type regions so that all charge carriers travelling between electrodes have to pass through some of the *n–p* transition regions. In the transition region a quasi-intrinsic behaviour is observed. C. A. HOGARTH

537.312.5

7995. The magnitude of dark conductivity as criterion of stationary and relaxation properties of photo-conductivity. D. B. GUREVICH AND N. A. TOLSTOĬ. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 3) 473–6 (1950) *In Russian.*

The division of photo-resistivities (ph.r.) into exponential and hyperbolic classes coincides with their usual division into linear ph.r. with this difference that the change in stationary properties has been compared here with a change in relaxation properties. The stationary and relaxation laws of ph.r. of the exponential class are expressed as a function $\Delta\sigma = E\phi(t)$, and the stationary and relaxation laws of ph.r. of the hyperbolic class as a function $\Delta\sigma = \sqrt{E}f(t\sqrt{E})$; where the stationary photo-conductivity $\Delta\sigma_0$ is $\propto$ to the illumination E and the relaxation time τ is independent of E. The theoretical discussion refers to two distinct cases: $\sigma \ll \Delta\sigma_0$ and $\sigma \gg \Delta\sigma_0$. Exponential (linear) ph.r. results when dark conductivity $\sigma >$ photo-conductivity $\Delta\sigma_0$; hyperbolic (non-linear) ph.r. results when $\sigma \ll \Delta\sigma_0$. When σ is comparable with $\Delta\sigma_0$ complicated stationary and relaxation effects are to be expected. Z. F. WOJNAR

537.312.5

7996. The measurement of quantum output of internal photo-effect in a cuprous oxide. S. M. RYVKIN. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 3) 481–4 (1950) *In Russian.*

The magnitude of photo-conductivity determinable from the properties of the substance under investigation and not the magnitude of the photo-current is used for the measurement of the quantum yield β. Methods are indicated for the measurement of the stationary photo-conductivity in Cu_2O, the time of life of photo-current carriers, their mobility and full intensity of light falling on the specimen (in quanta per sec). The value for the quantum yield at room temperature ($\sim 1\%$) disagrees with the theory (quantum yield expected 50%) developed by the author previously. Z. F. WOJNAR

537.312.5

7997. Constitution and mechanism of the selenium rectifier photocell. J. S. PRESTON. *Proc. Roy. Soc. A*, **202**, 449–65 (*Aug.* 22, 1950).

Describes experiments to elucidate the exact physical and chemical structure of the Se rectifier photocell, especially that of the thin surface film. A technique is described for sputtering films of CdO which, though transparent in the thickness required for a cell, have an electrical conductivity exceeding that of graphite. The thickness of the films can be closely controlled. With such films, on pure crystalline Se, cells were produced with white-light sensitivities of over 700 μA per lumen, open-circuit voltages up to 0·5 V under high illumination, and maximum quantum efficiencies up to 70%. The optical properties of the films are described, and the way in which the technique may be used to produce other non-metallic films is indicated. The CdO is found to have a negative Hall coefficient, and is therefore an *N* type semi-conductor. Further experiments with single films of Au, and double films of ZnO and Au, illustrate the behaviour of these, in intimate contact with Se. The metal-Se contact yields a poor photocell, the metal-Zn oxide-Se contact one whose properties are critically dependent on the thickness of the intermediate oxide layer, and the *N* type CdO–Se contact one for which the efficiency is high, and the thickness of CdO not critical. It is suggested, therefore, that in the practical photocell, the essential mechanism is a contact between two suitable semi-conductors of dissimilar types, any extra metal film when present serving simply to raise the lateral conductivity of the intermediate semi-conducting film when this is not high enough to eliminate undesirable effects of a high internal resistance in the finished cell. A.

537.312.5

7998. The photon yield of electron-hole pairs in germanium. F. S. GOUCHER. Letter in *Phys. Rev.*, **78**, 816 (*June* 15, 1950).

537.312.5

7999. Photo-conductivity in amorphous selenium. P. K. WEIMER. Letter in *Phys. Rev.*, **79**, 171 (*July* 1, 1950).

537.312.5 : 548.0

8000. Photo-electric properties of diamond, measured with a crystal counter. G. P. FREEMAN AND H. A. VAN DER VELDEN. *Physica*, **16**, 486–92 (*May*, 1950).

In this article measurements are described of the function of Hecht for diamond. The result differs considerably from earlier measurements in which light or electrons are used to irradiate the crystal. Attention is drawn to the important fact that the photo-electric measurements in a crystal, performed with the aid of a crystal counter, are more accurate and reliable than older methods. A.

537.312.5 : 621.383

8001. Electron-multiplier photocell for the far ultraviolet. V. SCHWETZOFF AND S. ROBIN. *C.R. Acad. Sci., Paris*, **230**, 1759–61 (*May* 15, 1950) *In French.*

The cell constructed has a cathode of Cs_2O covered with a film of Na, the secondary emission electrodes are coated with Cs_2O and the window is quartz. The dark current is 3×10^{-9} A at an amplification of 20 000 times; sensitivity of cathode is 10 μA/lumen with tungsten filament at 2 600°K. Tested with a hydrogen lamp (fluorite window) and grating monochromator the response, after correction for loss by the quartz window, is a maximum at 3 400 Å; at 1 800 Å it is $\frac{1}{3}$ max., and at 5 000 Å, $\frac{1}{4}$ max.

G. F. LOTHIAN

537.312.5 : 621.389

8002. The detection of short light flashes by means of electron multipliers. F. VALENTIN. *C.R. Acad. Sci., Paris*, **230**, 2271–2 (*June* 26, 1950) *In French.*

The light pulses are produced by discharging a

condenser through a mercury vapour arc. The amplifier is of the a.c. type. The bandpass filter of the amplifier passes a band of the width of $1 \cdot 2/t$ c/s where t(sec) is the duration of a flash. The brilliancy of each light pulse is $B/50t$ when B is the average brilliancy of the Hg tube and the flash rate is 50/sec. The signal-to-noise ratio is then $B/55K\sqrt{t}$. With a classical d.c. amplifier this ratio would be $B/K\sqrt{0 \cdot 2}$. A reduction in the duration of the flash reduces the threshold of detection. Flashes of 10 μsec have been obtained. Pulses < 1 μsec are attainable.

W. SUMMER (R)

537.312.62

8003. Superconductivity of columbium. D. B. COOK, M. W. ZEMANSKY AND H. A. BOORSE. Letter in *Phys. Rev.*, **78,** 820–1 (*June* 15, 1950).

537.312.62

8004. Isotope effect in superconductivity. H. FRÖHLICH. Letter in *Proc. Phys. Soc., Lond. A,* **63,** 778 (*July,* 1950).

537.312.62

8005. Superconductivity of Sn^{124}. E. MAXWELL. Letter in *Phys. Rev.*, **79,** 173 (*July* 1, 1950).

537.312.62 : 539.155.2

8006. Superconductivity of isotopes of mercury. B. SERIN, C. A. REYNOLDS AND L. B. NESBITT. Letter in *Phys. Rev.*, **78,** 813–14 (*June* 15, 1950).

537.312.8

8007. Effect of magnetic fields on conduction—"Tube integrals." W. SHOCKLEY. Letter in *Phys. Rev.*, **79,** 191–2 (*July* 1, 1950).

Effect of field H on electrical conduction may be reduced to integrals by using concept of "tubes," or regions bounded by planes P_H and $P_H + dP_H$ and energy surfaces $E(P) = E$ and $E + dE$, where P_H is an axis parallel to H in the $P = hk$ space of the Brillouin zone. The total current may be obtained as a linear function of electric field where the coefficients are integrals involving H. This analysis may make possible the determination of the energy surface parameters for Ge [see Abstr. 5824 (1950)] from magneto-resistance measurements on single crystals.

C. A. HOGARTH

537.312.8

8008. The electrical conductivity of bismuth fibres.—II. Anomalies in the magneto-resistance. B. DONOVAN AND G. K. T. CONN. *Phil. Mag.*, **41,** 770–82 (*Aug.*, 1950).

In examining the magneto-resistance of thin fibres of Bi, which are known from previous work to approximate to single crystals, it was found that a considerable proportion of these, about 10%, showed a decrease in the resistance on application of a magnetic field. The effect is only present in fields of the order of 1 000 oersteds or less and is of the order of $10^{-4}\rho_0$. The influence of direction of current, direction of field and orientation of the crystal axes is examined. It is considered that these observations provide the first unequivocal evidence of the existence of a longitudinal Hall coefficient. Used in conjunction with the theory of conduction in anisotropic solids, it is possible to indicate the appropriate crystal orientation. It has not, as yet, been possible to designate this with accuracy.

A.

537.312.8 : 537.311.33

8009. Magnetoresistance of germanium samples between 20° and 300°K. I. ESTERMANN AND A. FONER. *Phys. Rev.*, **79,** 365–72 (*July* 15, 1950).

The resistivity of "pure" Ge samples and of samples with small additions of Al, Sb and In was measured at various temperatures and at various orientations in external magnetic fields. The samples chosen had sufficiently low carrier densities to remain within the limits of classical statistics. The results were compared with those following from the theoretical investigation of a classical electron gas in combined electric and magnetic fields in an isotropic medium and in a medium possessing cubic symmetry. In the transverse orientation, the relative change of the electrical conductivity was found to be proportional to the square of the magnetic field strength at low fields. The effect tends to become linear as the field strength increases. The magnitude of the effect was found to increase with the purity of the material. In the longitudinal orientation, the change of conductivity is of the expected order of magnitude in p-type samples, but is much larger than the theoretical results indicate in n-type samples. The angular dependence of the effect is as expected. Carrier mobilities calculated from magneto-resistance measurements in pure samples agree reasonably well with those calculated from Hall effect and conductivity of single crystals. In the case of samples with additions, there is fair agreement between the values of mobilities calculated from measurements of magneto-resistance and of the Hall effect on the same samples.

A.

537.312.8 : 537.311.33

8010. Note on the theory of resistance of a cubic semiconductor in a magnetic field. F. SEITZ. *Phys. Rev.*, **79,** 372–5 (*July* 15, 1950).

The theory of the behaviour of a classical electron gas in combined electric and magnetic fields, developed by Gans and extended by Sommerfeld and Davis, is applied to a system possessing cubic symmetry. The problem is limited to that case in which terms involving the magnetic field to higher than the second power are neglected.

A.

537.36

8011. Electrokinetic properties of cellulose fibers. I. D. A. I. GORING AND S. G. MASON. *Canad. J. Res. B,* **28,** 307–22 (*June,* 1950).

Stream potential, electro-osmotic, and permeability measurements were made on cotton pads in the presence of distilled water. The Briggs method of evaluating the "pore factor" by electrical conductivity measurements was found to be invalid. An alternative method of determining the factor is proposed, based on an assumed value for the pore orientation factor and an indirectly measured value of the swollen specific volume of the fibres. The electro-osmotic measurements were found to require a large correction for capillary electro-osmosis, a source of error which has been overlooked by other workers. The ratio of the ζ-potential calculated from electro-osmosis to that from the stream potential was greater than unity and increased with increase in pad concentration.

A.

537.36

8012. Electrokinetic properties of cellulose fibers. II. D. A. I. GORING AND S. G. MASON. *Canad. J. Res. B*, **28**, 323–38 (*June*, 1950).

A new technique of measuring the ζ-potential of cellulose fibres, in which stream current potential measurements are carried out over a range of solid concentrations on a single pad, is described. Degrees of swelling calculated from the stream data are consistently higher than those calculated from permeability measurements. This discrepancy indicates a serious limitation of the conventional electrokinetic theory when applied to swollen cellulose. A model of the fibre–liquid interface, consisting of partially dissolved electrically charged cellulose chains accounting for the observed discrepancy, is discussed. If this model is applicable, the physical significance of the ζ-potential becomes extremely complex. A.

537.36

8013. Electrokinetic properties of cellulose fibers. III. D. A. I. GORING, G. J. BIEFER AND S. G. MASON. *Canad. J. Res. B*, **28**, 339–44 (*June*, 1950).

Sulphite cellulose, rayon cellulose and silk fibres in the presence of 10^{-4} *N* KCl show a 20 to 25% decrease in electrical resistance between 0 and 100 c/s. An additional but smaller decrease occurs between 100 and 15 000 c/s. The systems also show a marked capacitive reactance. Reversal of the sign of the ζ-potential in sulphite fibres destroys the effect. Non-swelling fibres such as asbestos, glass and acetate rayon, slightly swelling nylon, and moderately swelling wool show no comparable behaviour. It is evident that the phenomenon is related to the swelling properties of the systems, but it cannot be concluded whether it is associated with the surface or the interior of the swollen fibres. A.

537.363 : 541.18

8014. A microscopic electrophoresis cell. A. J. RUTGERS, L. FACQ AND J. L. VAN DER MINNE. *Nature, Lond.*, **166**, 100–2 (*July* 15, 1950).

For the accurate microscopic measurement of the electrophoretic speed of particles in a colloid or suspension, an apparatus is described for obtaining the liquid stagnant in the axis of the cell. The advantages of the previous attempts of Van der Grinten [*J. Chim. Phys.*, **23**, 226 (1926)] and of Smith and Lisse [*J. Phys. Chem.*, **40**, 399 (1936)] are included, and the disadvantages are avoided, by creating the pressure necessary to bring movement in the axis to zero by making the liquid flow through an extension of the same capillary. Measurements with emulsions of tetraline (+ 1% of palmitic acid) in water are recorded for testing the apparatus, and a remedy for avoiding astigmatism is suggested.

H. H. HODGSON

ELECTRIC DISCHARGES 537.52

537.521 : 537.523 : 537.525 : 621.38

8015. Gaseous-conduction phenomena and their application in electrical engineering. J. D. COBINE. *Elect. Engng, N.Y.*, **69**, 499–504 (*June*, 1950).

This paper, introductory to three further papers in the same series, deals descriptively with certain gaseous discharge phenomena such as low-pressure breakdown and the various forms of stable, self-maintained discharges. J. D. CRAGG

537.521 : 538.566.2 : 534.21

8016. Magneto-hydrodynamic waves in a plasma. E. ÅSTRÖM. Letter in *Nature, Lond.*, **165**, 1019–20 (*June* 24, 1950).

The propagation of magneto-hydrodynamic waves in a collision-free ionized gas is discussed. Two types of plane wave are possible for each angle ϕ that the wave-normal makes with the direction of the magnetic field. In one of these the motion is transverse, the energy flows along the lines of magnetic force, and the phase velocity depends on ϕ. In the other, the motion has a component along the wave normal, and the phase velocity is independent of ϕ. A. T. PRICE

537.521 : 538.566.2 : 534.21

8017. Magneto-hydrodynamic waves in a compressible fluid conductor. N. HERLOFSON. Letter in *Nature, Lond.*, **165**, 1020–1 (*June* 24, 1950).

When the forces due to elastic compression are taken into account, there is, in addition to the 2 magneto-hydrodynamic waves (see preceding Abstr.), a 3rd wave which is essentially a sound wave disturbed by electromagnetic forces. If the magneto-hydrodynamic velocity $V = H/\sqrt{(4\pi\rho)}$ is small compared with the velocity U of sound, the velocity of propagation is approximately $\sqrt{(U^2 + V^2 \sin^2 \phi)}$, where ϕ is the angle between the wave normal and the magnetic field. A. T. PRICE

537.521 : 538.566.2 : 551.510.535 : 523.74 : 621.396.61

8018. Electro-magneto-ionic optics. V. A. BAILEY. *J. Proc. Roy. Soc., N.S.W.*, **82** (*No.* 2) 107–13 (1948).

A theory of the emission of electric waves by discharge tubes, by the ionosphere and the solar atmosphere is developed from Maxwell's equations. The electric fields which can exist in a medium consisting of electrons, positive ions and molecules or atoms, subject to static electric and magnetic fields are considered. Solutions of the equations for plane waves are developed which specify the possible frequencies and damping coefficients of waves traversing the medium with a given (real) phase velocity and of the waves which can exist in the medium with a given (real) wavelength, also the possible refractive indices and attenuation coefficients under which waves of a given real frequency are propagated in the medium. If the collision frequency is small the wave may show negative absorption, i.e. the amplitude grows with time, and the gas should be capable of generating oscillations. This gives one explanation of the origin of solar, stellar and ionospheric noise. [Preliminary note, Abstr. 2846 (1948)]. J. H. MASON

537.523.4

8019. Mechanism of the spark breakdown. L. H. FISHER. *Elect. Engng, N.Y.*, **69**, 613–19 (*July*, 1950).

The experimental data of the d.c. spark in air in a uniform field are reviewed, and criteria for establishing the reliability of sparking potential measurements are suggested. The present concept of the mechanism of the spark in air is traced from the

early work of Townsend to the recent streamer theory of Loeb and Meek and Raether, and implications of recent measurements of the formative time lag of spark breakdown are discussed in detail. See also Abstr. 6516 (1950). A.

537.523.4

8020. Investigation of the initial stage of sparking. V. V. Mezhueva, I. S. Stekolnikov and A. Z. Efendiev. *J. Tech. Phys., USSR*, **20** (*No.* 3) 308–26 (1950) *In Russian.*

The results of the oscillographic investigation of sparking in widely varying conditions may be formulated thus: The character of the initial time relation $U_{sp}(t)$ remains essentially the same for diverse circuits and may approximately be represented by the expression $U_0 \exp(-at)$, where a is hardly influenced by circuit parameters, but varies very considerably between different voltage ranges. The marked increase of a in certain of these ranges leads to the conception of "energetically poor" sparks. A noteworthy retardation of the fall of $U_{sp}(t)$ is observed when I_m approaches 50 amp. Equations for determining i were derived for exponential variation of U_{sp} and by means of these the beginning of the retarded fall of U_{sp} could be forecast. The energy dissipated in the initial sparking stage was also determined theoretically as well as experimentally, with satisfactory agreement between the results. It was found that for given a this energy depends on the frequency. The problem of the theory of the initial phase of the power spark remains for the present unsolved; in particular, Toepler's law does not describe the U_{sp} relation correctly, except as a crude approximation. B. F. KRAUS

537.523.5 : 535.338.334

On the widening of spectral lines under the influence of ions and electrons. *See Abstr.* 7868

537.525 : 533.5

8021. On certain gaseous discharge phenomena occurring during the pumping of low voltage incandescent lamps. L. Dunoyer. *Vide*, **5**, 793–800 (*May*, 1950) *In French.*

It has been observed that the heating of a low voltage (2 V) filament in an evacuated envelope causes the emission of gas at a speed and volume whose values are proportional to the time interval between the stoving of the filament with subsequent gas discharge and the switching on of the filament current. This emission of gas into the vacuum is the result of the formation of skins of the gas on the walls of the previously stoved and evacuated glass vessel and tubes. These extremely thin layers of gas are adsorbed by the cold glass walls and, by superficial diffusion, move towards those parts which, by a previous stoving, have already given off their own adsorbed gas layer. A pumped system, once evacuated, should be sealed immediately. Delay will result in gas diffusing into the system where it may be freed during later operations. W. SUMMER

537.525.5 : 538.69

8022. Supersonic wind at low pressures produced by arc in magnetic field. H. C. Early and W. G. Dow. Letter in *Phys. Rev.*, **79**, 186 (*July* 1, 1950).

537.525.6

8023. Current fluctuations in d.c. gas discharge plasma. P. Parzen and L. Goldstein. Letter in *Phys. Rev.*, **79**, 190–1 (*July* 1, 1950).

537.527.5

8024. Extended theory of wall-stabilized high pressure mercury arcs. O. Koch. *Z. Phys.*, **127** (*No.* 5) 455–67 (1950) *In German.*

Mentions the importance of a knowledge of temp. variations of thermal conductivity in high pressure arc theory, and gives in detail new and extended calculations of arc temps., etc., in terms of various physical parameters such as gas pressure, wall radius and temp., etc. Good agreement between theory and practice is usually obtained, but discrepancies relating in particular to optical discharge diams. suggest that the theory is still incomplete. J. D. CRAGGS

537.529 : 539.23

8025. Electric strength of aluminium oxide films. P. D. Lomer. Letter in *Nature, Lond.*, **166**, 191 (*July* 29, 1950).

X-RAYS 537.531

537.531 : 535.312

8026. On the use of single crystals of aluminium in focalization techniques, in particular in X-ray spectrography. Y. Cauchois, T. J. Tiedema and W. G. Burgers. *Acta Cryst.*, **3**, 372–4 (*Sept.*, 1950) *In French.*

Plate-shaped Al single crystals were prepared with an atomic plane of high density parallel, or perpendicular, to their surface. Such crystals, after suitable plastic bending, followed by an annealing treatment, were used as reflectors in focusing X-ray spectrographs and spectrometers, both of the transmission and of the reflecting type. The intensities of the reflected beams were considerably higher than those obtained with elastically bent crystals of similar resolving power. A.

537.531 : 535.33

8027. The investigation of the fine structure of absorption spectra. I. B. Borovskiĭ and R. L. Barinskiĭ. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 1) 31–4 (1950) *In Russian.*

Reference is made to a paper by Borovskiĭ [*Izv. Akad. Nauk, SSSR, Ser. Fiz.* (*No.* 2–3) 184 (1941)] in which the fine structure of the fundamental absorption edge of transition elements is attributed to the superposition of the "line" and the continuous absorption processes. Further theoretical results are obtained from the study of the dispersion of X-rays in the given substance. The δ/λ^2-curve for Si coincides with the theoretical curve, while Ni shows a marked discrepancy, as foreseen by the hypothesis. An experimental investigation of the L and M series of the absorption and emission spectra of elements having defects in $3d$, $4d$ and $5f$ levels has confirmed the hypothesis both qualitatively and quantitatively. F. LACHMAN

537.531 : 535.33.072

8028. A new method of bending a crystal for a bent crystal X-ray spectrograph. I. B. Borovskiĭ. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 3) 485–7 (1950) *In Russian.*

Bending a crystal plate by cementing it to a curved surface proved unsatisfactory. A better method is to hold the crystal plate between two pairs of parallel rods which keep it bent into a true cylinder (the bending moment is constant over most of its length). About 75% of its surface can then be used. Eccentric sleeves on the rods can be used to change the curvature. See Abstr. following. A. L. MACKAY

537.531 : 535.33.072

8029. Application of the pure bending of a crystal plate in a crystal holder to focusing X-ray spectrographs. A. B. Gilvarg. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 3) 489–91 (1950) *In Russian.*

Development of the method described in the previous abstract. A composite bar of 2 thick steel or quartz bars and the thin quartz crystal is bent by a large moment applied through 2 pairs of knife-edges. The crystal is clamped so that it takes the curvature of the neutral section. The rigid construction and large forces used enable the apparatus to resist shocks and at the same time the radius of curvature of the crystal can be easily adjusted. A. L. MACKAY

537.531 : 535.43

8030. Small angle diffuse scattering of X-rays. E. A. Poraĭ-Koshits and Yu. G. Sokolov. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 3) 477–80 (1950) *In Russian.*

The problem is examined of finding the dimensions, form and distribution of particles or pores (with sizes of 20–1 000 Å) from the scattering of X-rays ($\lambda \simeq 1{\cdot}5$ Å) through angles $\phi \leqslant 1°$. The general theory is incomplete, but solids composed of particles or pores separated by distances $\geqslant$ their radii can be treated as gases. The log. of the scattered intensity is then found to be $\propto \phi^2$ [A. Guinier, *J. Chim. Phys. Biol.*, **40**, 133 (1943)]. Solids made up of close-packed spheres can be treated as liquids in which interference occurs between scattered waves and to which the formula of Zernicke and Prins is applicable. An experimental test of the low-angle method was made by measuring the radii of pores in microporous soda-boro-silicate glass by absorption of water or ethanol and comparing the results with those calculated from photometer traces of low-angle X-ray photographs. ϕ ranged from 10·5′ to 1° 25′. Satisfactory agreement was obtained. A. L. MACKAY

537.531 : 535.5

8031. A study on the polarisation of X-rays. H. K. Pal. *Indian J. Phys.*, **24**, 91–3 (*Feb.*, 1950).

In this paper the variations of the polarization of a heterogeneous primary beam of X-rays with the variation in (i) the magnitude of the generating h.t., and (ii) thickness of an Al filter through which the rays were transmitted, have been studied. It is observed that a lowering of the voltage applied or an increase in the thickness of the filter has the effect of producing an increased p.c. polarization of the beam. A.

537.531 : 537.11

8032. Pair production in the field of the electron by X-rays from a 100 MeV betatron. E. R. Gaerttner and M. L. Yeater. Letter in *Phys. Rev.*, **78**, 62 (*June* 1, 1950).

This was studied using a cloud chamber. The ratio of triplets to pairs in the primary X-ray energy regions 5–20 MeV, and 20–100 MeV, was measured and a correction made for undetected triplets. Agreement was obtained between the theoretical and experimental ratios of the average pair to triplet cross-sections. J. HUGHES

537.531 : 621.386.1 : 621.385.83

8033. A study of an electron focusing system in an X-ray tube. J. S. Thorp. *Brit. J. Appl. Phys.*, **1** 144–9 (*June*, 1950).

The distributions of electron density in typical foci obtained with a simple electron focusing system in a demountable X-ray tube have been determined by a combination of electrolytic trough and ray tracing methods. On the simplest electron-optical basis good qualitative agreement is obtained with the foci observed experimentally, but the observed focal dimensions are always found to be greater than those predicted. The effects of thermal energies of emission and of mutual repulsion are discussed, and it is suggested tentatively that the quantitative discrepancy is due to space charge effects. [See also Abstr. 4811 (1949)]. A.

CATHODE RAYS . POSITIVE RAYS 537.533/.53

537.533 : 621.3.015.1 : 621.319.

8034. Potential distribution in a spherical capacitor in saturation current conditions. R. P. Poplavskiĭ. *J. Tech. Phys., USSR*, **20**, 149–59 (*Feb.*, 1950) *In Russian.*

Kan [*J. Tech. Phys., USSR*, **18** (*No.* 4) 48 (1948)] gave a rigorous solution of the potential problem in a spherical capacitor with a thermionic current limited by space charge ("Langmuir" problem) and suggested a generalization especially for saturation current conditions. The theoretical possibility is, however, severely limited by the mathematical difficulty of determining the constants of integration. A more convenient way is to relinquish Bessel functions in favour of Airy functions, analysed and tabulated by Fock. The method offers great advantages for any stationary problem of thermionic or photo-electric emission where the initial velocity of the electrons may be neglected; where this is not the case it requires modifications, though formally correct. B. F. KRAU

537.533 : 621.384.

8035. Determination of the pole faces of a betatron by a model. J. J. Orlin. *Bergens Museums Årb.* (*No.* 1) *Paper* 5, 9 *pp.* (1949).

Measurements on a ¼-scale model, used to determine the correct pole face profile to give focusing, are described for the 94 cm dia., Bergen betatron. J. HUGHES

537.533.7 : 530.145

8036. The Cerenkov radiation. E. MAURER AND H. KOLZ. *Z. angew. Phys.*, **2** (*No.* 5) 223–9 (1950) *In German.*

The paper is a comprehensive review of work done on the Cerenkov radiation to date. It deals with the production and properties of the radiation, comparison between Cerenkov radiation and similar phenomena, theory of the radiation and its applications. A description of the Cerenkov counter for electrons and mesons is included. Z. F. WOJNAR

537.533.72 : 621.385.833

8037. Contribution to the study of the electrostatic cylindrical lens consisting of an infinitely long slit in a metal plate. J. BALTÁ ELÍAS AND J. A. GÓMEZ GARCÍA. *An. Real Soc. Esp. Fis. y Quím.*, **46A**, 83–92 (*March–April*, 1950) *In Spanish.*

537.533.72

8038. The increase of temperature of metallic specimens in the electron microscope. H. FORESTIER, C. HAASSER AND M. UHL. *C.R. Acad. Sci., Paris*, **230**, 2080–2 (*June* 12, 1950) *In French.*

By measuring the beam intensity necessary to melt dispersed specimens of various metals in the electron microscope an assessment is made of the factors on which the temperature of a specimen depends. It is concluded that, for a given beam intensity, the temperature increases with grain size and, for a given temperature, the beam intensity needed decreases with density. For elements belonging to the same period the temperature increases rapidly at first with increasing beam intensity but quickly tends to a limit. J. THEWLIS

537.533.72

8039. The determination of resolving power by Fresnel diffraction in the electron microscope. L. WEGMANN. *Helv. Phys. Acta*, **23** (*No.* 4) 437–52 (1950) *In German.*

A criticism of the method of determining the instrumental resolving power of an electron microscope by measuring the distance between the maximum and minimum which can just be resolved in a Fresnel diffraction pattern of a straight edge. A theoretical analysis and the results of experimental work lead the author to conclude that the method gives a better value for the resolving power than is justifiable. M. R. HOPKINS

537.533.72

8040. Elastically and inelastically scattered electrons in electron microscope dark field images. G. MÖLLENSTEDT. *Optik*, **6** (*No.* 4) 251–5 (1950) *In German.*

An experiment is described, in which it is shown how the elastically and inelastically scattered electrons can be made to produce separately visible effects in an electron micrograph. The central electrode of the electrostatic lens of the objective was moved slightly off centre, and dark field conditions produced by placing a fine Pt wire in the focal plane of the objective to screen off the reduced image of the electron source. M. R. HOPKINS

537.533.72

8041. The focusing properties of inhomogeneous magnetic sector fields. N. SVARTHOLM. *Ark. Fys.*, **2**, *Paper* 14, 115–18 (1950).

The focal properties are studied and expressions given by which the image construction can be deduced from the construction valid for the homogeneous case. The advantages of the field $H = H_0 \cdot 2r_0(r + r_0)^{-1}$, which can be obtained from conical pole pieces of spacing $2z = z_0(r + r_0) \cdot r_0^{-1}$ are pointed out. A. H. W. BECK

537.533.72 : 538.082.74

Measurement of magnetic field of a nuclear spectrometer. *See Abstr.* 8113

537.533.72 : 539.165

8042. A mathematical analysis of the C. M. Witcher's beta-ray spectrometer of a type using helical orbit. Y. KOH. *J. Phys. Soc. Japan*, **4**, 245–51 (*July–Dec.*, 1949).

The optimum dimensions and positions of the annular baffles are derived for the case of a point source on the central axis of the spectrometer, using a graphical method. Transmission curves are given for 2 optimum cases, one using a single annular aperture and disk-shape aperture at the detector, the other using 2 annular apertures (ring focus). The case of a point source displaced from the axis of the spectrometer is also considered. L. R. SHEPHERD

537.533.72 : 539.165

8043. A new type of β-ray spectrograph. O. KOFOED-HANSEN, J. LINDHARD AND O. B. NIELSEN. *K. Danske Vidensk. Selsk. Mat.-fys. Medd.*, **25** (*No.* 16) 27 *pp.* (1950).

The theory is given of an axially symmetrical β-spectrometer, with magnetic field $1/r$, and source and focus both outside the magnetic field. True image formation and large solid angle are features of the design. Experiments with a model consisting of a single wedge-shaped gap indicate that a solid angle of 20% of 4π, and resolution of 2%, should be obtainable with an instrument consisting of 6 such gaps disposed symmetrically about the axis. B. ROSE

537.533.72 : 539.165

8044. On an improvement in β-ray lens spectrographs. P. GRIVET. *C.R. Acad. Sci., Paris*, **230**, 1652–4 (*May* 8, 1950) *In French.*

Continuation and correction of previous notes [Abstr. 6535–6 (1950)] on a double focusing spectrograph. Formulae are stated for magnification, size of ring focus, dispersion, resolving power, etc. B. ROSE

537.533.72 : 539.165

8045. A high resolution beta-ray spectrometer. J. A. BRUNER AND F. R. SCOTT. *Rev. Sci. Instrum.*, **21**, 545–7 (*June*, 1950).

A relatively inexpensive 180° magnetic focusing beta-ray spectrometer has been constructed, having a principle orbit radius of 15 cm. A radially inhomogeneous field provides essentially perfect focusing of electrons leaving the source within a 33° angle. In operation, with a 1 mm wide source, the transmission is 0·2%, the full width at half-maximum of an internal conversion line is 0·4%, and the effects of background and scattering are generally inappreciable. A.

537.533.8

8046. The probability distribution of the number of secondary electrons. P. S. FARAGÓ AND L. TAKÁCS. *Hungar. Acta Phys.*, **1** (*No.* 6) 43–52 (1950).

A method of estimating the probability distribution

of secondary electrons from observed distributions of pulse amplitude of plate current from a multiplier tube using (i) $(k-1)$ and (ii) k stages. Application of the method to other similar problems is discussed.

N. L. JOHNSON

537.533.8

8047. A theory of secondary electron emission from metals. E. M. Baroody. *Phys. Rev.*, **78**, 780–7 (*June* 15, 1950).

A theory is formulated on the basis of the Sommerfeld free-electron model, momentum transfer between electrons and lattice being included by introducing a finite mean free path for elastic scattering. The approach to the problem is similar to that of Kadyschewitsch, but the development is simpler and comparison with experiment is made in more detail. An understanding is reached of the influence of work function and the width of the conduction band, making it clear why, on the average, metals with large work function might be expected to be the best emitters. The observed effect of changing the work function of a given metal by surface layers of foreign atoms is interpreted, an inverse relationship between emission and work function being obtained which is in qualitative agreement with experiment. The theory also accounts for the velocity distribution of the secondaries, giving the general shape of the curve and determining the approximate position of the maximum, and is consistent with the observed angular distribution of the secondaries. The investigation is not carried far enough to give new theoretical information concerning the variation of secondary emission with primary energy. However, the relation of the present theory to some work of Bruining is indicated, and attention directed to an important empirical relationship. A.

537.533.8 : 621.396.616 : 621.385.15

8048. On the time delay of secondary emission. G. Diemer and J. L. H. Jonker. *Philips Res. Rep.*, **5**, 161–72 (*June*, 1950).

The frequency limit of a disc-seal dynatron proves to be 2 400 Mc/s. From this an upper limit of 3×10^{-11} sec for the time lag τ of secondary emission is derived. Measurements on the admittance of an u.h.f. dynatron at 300 Mc/s show that the time lag must be $< 10^{-11}$ sec. From transit-time effects within the secondary-emitting material an upper limit for τ of the order of 10^{-14} to 10^{-15} sec may be estimated theoretically. A.

537.533.8 : 778.33

Observations concerning the secondary electronic emission from certain materials by means of its photographic action. *See Abstr.* 8414

537.533.9

8049. Evaporation of zinc and zinc oxide under electron bombardment. F. E. Dart. *Phys. Rev.*, **78**, 761–4 (*June* 15, 1950).

By use of a mass spectrographic method, the rate of evaporation of Zn and ZnO is measured as a function of temperature both with and without electron bombardment of the surface being evaporated. In the case of Zn metal no increase of evaporation could be detected as resulting from bombardment whereas a definite increase was observed in the evaporation of ZnO. The enhancement of the evaporation rate of ZnO increases slowly at first and then rapidly with increasing temperature. A.

537.534.72

8050. Dispersion and aberration in the magnetic mass-spectrograph. L. Musumeci. *Nuovo Cim.*, 7 (*No.* 3 *bis*) 351–63 (*May*, 1950) *In Italian.*

A detailed theoretical study of the focusing of the beam in the condition of maximum dispersion of the images. L. PINCHERLE

537.534.72

8051. Effects of initial energies on mass spectra. C. E. Berry. *Phys. Rev.*, **78**, 597–605 (*June* 1, 1950).

The slit system of a conventional mass spectrometer discriminates against ions having initial kinetic energies. Relations between the amount of the discrimination and the geometry of the system are developed and confirmed experimentally for ions having only thermal energy. Curves showing the discrimination against high energy fragments from a number of simple molecules are given. These show that measured relative abundances depend strongly on the geometry of the system and on the accelerating voltage. In theory, the initial velocity distribution can be obtained from discrimination data. This method is shown to be impractical, and a better method is described, which involves electrostatic deflection of the ion beam in a direction parallel to the magnetic field. Curves of ion intensity v. deflecting potential give directly the shape of the distribution for one component of initial velocity. Distribution curves are given for the same ions for which discrimination curves were obtained. A.

537.534.74

8052. Multiple scattering in an infinite medium. H. W. Lewis. *Phys. Rev.*, **78**, 526–9 (*June* 1, 1950).

The integro-differential diffusion equation of the multiple scattering problem in an infinite, homogeneous, medium, is studied without the usual small-angle approximation. An expansion in spherical harmonics is carried out which is rapidly convergent in the case of large-angle scattering, whose coefficients can be exactly determined, and which leads to expressions for the various moments of the spatial and angular distributions. The results are shown to include earlier ones. Abstr. 2705 (1940); 6262 (1949). A.

537.534.74

8053. The scattering of protons by protons near 30 MeV, photographic method. W. K. H. Panofsky and F. L. Fillmore. *Phys. Rev.*, **79**, 57–70 (*July* 1, 1950).

The scattering of 29·4 MeV protons by H gas at 1 atm. pressure has been studied with the beam of the Berkeley linear accelerator. The beam, collimated to a diameter of $\frac{1}{16}$ in, passes through the gas and constitutes a line source of scattered protons. The scattering angle of the scattered protons is measured directly in the emulsion of 50 μ Ilford C-2 emulsions. Measurements of the range of the scattered protons was made on a fraction of the tracks. From range-energy relations established in the magnetic field of the 184 in cyclotron for the emulsions used, the

primary energy of the protons before scattering was found to be $29{\cdot}4 \pm 0{\cdot}1$ MeV. Protons were observed in the angular range $10° \leqslant \theta_{lab} \leqslant 80°$; two independent sets of scattering data in the angular region greater or less than 45° are thus obtained; a valuable internal check on observational errors or background or impurity effects is thus possible. No statistically significant difference in the two regions was observed. 10 934 tracks have been tabulated; this results in the statistical error approximately matching systematic errors such as those due to tolerance of plate geometry, observational error, etc. Cross-sections obtained are absolute; the beam is measured by absorption in a Faraday cup and charge integration on a low leakage condenser. The most significant result of these experiments is the apparent absence of expected repulsive *P* wave and of *D* wave effects. A.

537.534.74

8054. Proton-proton scattering at 31·8 MeV, proportional counter method. B. CORK, L. JOHNSTON AND C. RICHMAN. *Phys. Rev.*, **79**, 71–80 (*July* 1, 1950).

Differential cross-section measurements for proton-proton scattering have been made with protons of 31·8 MeV incident energy, scattered from H at one atm. pressure. Seven increments of angles from 15° to 51° in the laboratory system of co-ordinates have been measured simultaneously using proportional counters. In order that measurements could be made with very small currents, axially symmetrical defining slits and counters were made to include large solid angles. A 90° coincidence method was also used at large angles to give an independent geometry and to detect the possibility of slit and contamination scattering. The ratio of the differential cross-section at 30° to that at 90°, centre of mass system, is observed to be compatible with pure *S*-wave scattering of approximately 50° phase shift. A.

537.534.74

8055. Proton-proton scattering at 340 MeV. O. CHAMBERLAIN AND C. WIEGAND. *Phys. Rev.*, **79**, 81–5 (*July* 1, 1950).

Measurements of the *p-p* differential scattering cross-section using 340 MeV protons show a cross-section approximately constant between 41° and 90° in the centre of mass system. Two methods of counting the scattered protons have been used. The first method uses a counter telescope to count the scattered protons. The second method utilizes coincidences between counters which record the 2 protons involved in a single scattering process. The first method gives slightly higher cross-sections; the average value of the differential cross-section is $(5{\cdot}5 \pm 1{\cdot}0) \times 10^{-27}$ cm² steradian^{-1} in the centre of mass system. Although the scattering appears isotropic it is larger than can be accounted for with pure *S*-scattering. There is a strong suggestion, but no positive proof, that *n-p* and *p-p* forces are different. The *p-p* scattering at high energy is even qualitatively different from *n-p* scattering at comparable energy. In the *p-p* scattering the presence of other than *S*-wave scattering is evidenced in the magnitude of the cross-section but not in the angular dependence in the range 41° to 90° centre of mass system. A.

537.534.74 : 539.185

Polarization of protons by scattering. *See Abstr.* 8242

537.534.74 : 778.34

8056. On the measurement of scattering in the photographic plate. V. GOLDSCHMIDT-CLERMONT. *Nuovo Cim.*, **7** (*No.* 3 *bis*) 331–50 (*May*, 1950).

The paper describes methods for the determination of mass, charge and velocity of highly energetic particles by measuring their multiple scattering in photographic emulsion layers. By means of a special protractor attached to the measuring miscroscope, scattering angles as low as 10^{-2} degrees of arc per 100 microns can be measured, corresponding to energies $> 10^9$ eV. The various sources of error are discussed. The "noise level" is of the order of 1·5 minutes for 380 μ track length, indicating that distortion during processing does not constitute an important source of error. W. F. BERG

537.534.75 : 778.34

8057. On the range-energy relation in nuclear emulsions. P. CÜER, J-J. JUNG, D. MAGNAC-VALETTE AND S. GORODETZKY. *C.R. Acad. Sci., Paris*, **230**, 2280–2 (*June* 26, 1950) *In French.*

The range-energy relation for protons has been investigated over the range 0·5 to 40 MeV. The results can be put in the form $E = (CR)^{\alpha}$ where α lies between 0·74 and 0·6, and $C = 0{\cdot}0745 \pm 0{\cdot}0005$. Agreement with theory is stated to be good.

G. O. BAINES

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 537.534

8058. Principle of an ion source for intense beams. C. CASSIGNOL. Letter in *Nature, Lond.*, **166**, 233–4 (*Aug.* 5, 1950).

537.542

8059. The theory and properties of low voltage radiation counters. J. A. SIMPSON, JR. *Rev. Sci. Instrum.*, **21**, 558–68 (*June*, 1950).

The behaviour of permanent gas mixtures which lead to low breakdown potentials is discussed, and criteria are established for attaining minimum threshold and operating potentials for G.M. counters. Curves showing the dependence of counter characteristics upon pressure and electrode parameters have been obtained for various mixtures of Ne and A. The properties of cathode surfaces have been investigated and the criteria for obtaining suitable surfaces for counter operation were found. Two classes of counters were observed using these permanent gas mixtures. The first class possesses the lowest range of threshold potentials (approximately 115 to 135 V) at pressures up to approximately 7 cm Hg. They require quenching circuits having relatively long time constants. The second class of counters have threshold potentials in the range of approximately 135 to 210 V corresponding to pressures from 7 to 50 cm Hg. They operate with fast quenching circuits. Miniature portable radiation detectors and meters have been made using these detectors. A.

537.542

8060. Mechanism of the Geiger discharge. S. WERNER. Letter in *Nature, Lond.*, **165**, 1018–19 (*June* 24, 1950).

It is suggested that ionization by positive ions (Townsend's β mechanism) is an operative mechanism in the process of avalanche formation in Geiger counters and the consequences of this suggestion lead to a sparking equation which, it is claimed, agrees with observed data in H and N. J. D. CRAGGS

537.542

8061. Proportional counters. I. S. A. KORFF. *Nucleonics*, **6**, 5–10 (*June*, 1950).

A brief outline of the theory of operation of proportional counters includes an expression for gas amplification in terms of measurable parameters. Experimental curves of amplification factor *v.* counter voltage, which are in substantial agreement with the theory, are given for A, CH_4 and mixed fillings in a typical counter at various pressures. The operation of a counter in the region of limited proportionality is described. The advantage in the speed of operation of the proportional counter over that of the Geiger type is explained. L. R. SHEPHERD

537.542

8062. The velocity of propagation of the discharge in Geiger–Müller counters. H. SALTZMANN AND C. G. MONTGOMERY. *Rev. Sci. Instrum.*, **21**, 548–9 (*June*, 1950).

This was measured in a counter with a divided cathode by the method of delayed coincidences. The parameters varied were the counter potential and the percentage of ethyl alcohol mixed with A. The results are compared with Wilkinson's theory. Good agreement is obtained except for high velocities where the theory predicts values much too low. A.

537.542

8063. A method of measuring spurious counts in Geiger–Müller counters. D. WILLARD AND C. G. MONTGOMERY. *Rev. Sci. Instrum.*, **21**, 520–1 (*June*, 1950).

A counter was excited by a series of X-ray pulses of short duration occurring at regular intervals. Spurious counts were then easily recognized since they occur between the X-ray pulses. The counter pulses were displayed on an oscilloscope screen with a synchronized sweep and the counter deadtime, recovery time and number of spurious counts determined by inspection. More quantitative information of the time distribution was obtained with an electronic circuit that recorded counts in a small arbitrarily chosen interval. It was found that the interval distribution shows at least two maxima. A mechanism is suggested for the appearance of the second maximum in terms of negative ions formed at the cathode by positive-ion bombardment. A.

537.542

8064. End and wall corrections for absolute beta-counting in gas counters. A. G. ENGELKEMEIR AND W. F. LIBBY. *Rev. Sci. Instrum.*, **21**, 550–4 (*June*, 1950).

A^{37} (2·8 keV Auger electrons) and Kr^{85} (0·74 MeV β) were used to determine end corrections for gas counters with flat ends and brass walls. The corrections were found to agree with those published previously for C^{14} (0·154 MeV). Argon–alcohol fillings were used with small quantities of the active gas being studied. Wall loss corrections were measured for Kr^{85} and calculated for A^{37}, C^{14} and Kr^{85}. It appears from the results that absolute beta-counting for energies from about 0·01 to 0·8 MeV to an accuracy of 1 or 2% can be accomplished by the use of flat end Geiger counters applying the corrections indicated. A.

537.542

8065. The efficiency of counting, for counter tubes with aluminium copper and gold cathodes, of X-rays in the energy range 5–60 KeV. H. SAURER. *Helv. Phys. Acta*, **23** (*No.* 4) 381–411 (1950) *In German.*

A detailed paper describing expts. with 5–60 KeV X-rays in which sensitivities of various Geiger counters, in terms of the response of a standard ionization chamber, were determined. Spatial (i.e. radial and longitudinal) variations of sensitivity were studied; numerous graphs of results are given. The absorption mechanisms are discussed. The data obtained in the present work (5–60 KeV) are plotted on a log curve of counter sensitivity against photon energy which covers the range 8–3 000 KeV.

J. D. CRAGGS

537.542

8066. Geiger counter for civilian defense use. H. D. LEVINE, H. J. DIGIOVANNI AND M. R. COE. *Nucleonics*, **6**, 56–9 (*June*, 1950).

The Geiger tube is required to indicate radiation intensity levels in the range 50–3 000 mr/hr and pass sufficient continuous current to record directly on a microammeter. Halogen quenched counters have been found satisfactory and can develop currents over 250 μA with an approximately logarithmic current response in the required radiation range. The counters are operated at 700 V, supplied from two 1·5 volt batteries by means of a vibrator, step-up transformer, cold cathode rectifier and a voltage regulator giving better than 1% stabilization with 2–100 μA current drain. L. R. SHEPHERD

537.542

8067. An investigation of AgCl crystal ionization chambers. L. A. GERASEVA, I. D. RAPOPORT, I. S. SHAPIRO AND I. G. SHEĬNKER. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 2) 261–4 (1950) *In Russian.*

The decrease of pulse size with total number of counts was investigated. This is discussed in terms of a non-uniform distribution of polarization in the crystal. Conditions necessary to minimize this effect are indicated. E. P. GEORGE

537.542 : 537.312.5

8068. The influence of red and infrared light on a crystal counter. H. A. VAN DER VELDEN AND G. P. FREEMAN. *Physica*, **16**, 493–500 (*May*, 1950).

The influence of red light in the reduction of the space charge built up in a crystal counter is described, especially for the case of a diamond crystal. The distribution of the pulses and the decreasing of the pulse-magnitude as a function of the irradiation with α-particles, as well as the increasing of this magnitude

with red light, is explained qualitatively. It is possible to maintain the counting property of the crystal for an unlimited time, if only the intensity of the light is sufficient. A.

537.542 : 539.164.08

8069. The use of diamonds as radiation detectors. Č. Šimáně. *Čas. Pěst. Mat. Fis.*, **75** (*No.* 1) *D*105–*D*108 (1950) *In Czech.*

More than 20% of opaque and badly shaped industrial diamonds of Brazilian origin were found to be sensitive to α-rays in vacuum. This sensitivity was localized at a few small regions of the diamonds' surface; this explains why the pulses are not observable at atmospheric pressure when they are masked by parasitic pulses due to the ionization of the ambient air. The same reason must account for the absence of any observable β- and γ-sensitivity which, however, has been frequently established on well-shaped and transparent diamonds. B. F. KRAUS

537.542

8070. Scintillation type alpha-particle detector. A. S. Goldin, E. R. Rohrer and R. L. Macklin. *Rev. Sci. Instrum.*, **21**, 554–7 (*June*, 1950).

A portable detector is described which can detect as few as 16 alpha-counts (32 disintegrations) per min because of the virtual elimination of spurious background. The upper limit of 50 000 counts per min is not inherent and can be raised by appropriate circuit changes. The instrument is stable and is unaffected by most atmospheric conditions other than strong sunlight. Gamma-radiation up to 14 000 mr/hr gives no detectable response on this alpha-meter. The probe is the size of a GT type radio tube with a shield, allowing access to relatively small spaces. The sensitive area is about $1 \times \frac{1}{2}$ in when a 931-A photomultiplier is used. A.

537.542

8071. The scintillation counter. R. W. Pringle. *Nature, Lond.*, **166**, 11–14 (*July* 1, 1950).

A review of the characteristics of scintillation counters such as phosphor efficiencies and decay times, types of multiplier available and counter response to different radiations. Applications to nuclear research, radioactive tracer work and geological surveys are mentioned. G. F. J. GARLICK

537.542 : 539.166.8

8072. Pair production and photoelectric effect in scintillation phosphors. P. R. Bell. *Science*, **112**, 7–9 (*July* 7, 1950).

Below 3 MeV the Compton and photo-electric effects are used to measure gamma-ray energies (NaI–Tl phosphor crystals). Above 3 MeV pair production provides an energy assessment. Above 7 MeV pair production is predominant in the energy spectrum. G. F. J. GARLICK

537.542

8073. A note on the automatic regulation of the h.t. for Geiger counters. C. Brachet. *C.R. Acad. Sci., Paris*, **230**, 2174–6 (*June* 19, 1950) *In French.*

Describes briefly, in descriptive terms, the regulation of Geiger counter h.t. sets by using the Geiger pulses themselves as criteria of stability and for the stabilization of the h.t. sets. The application to Maze counters is also mentioned. J. D. CRAGGS

537.542 : 621.318.572

8074. Mechanism of the operation of a quenching circuit for Geiger–Müller counters. L. Bell. Letter in *J. Exp. Theor. Phys., USSR*, **20**, 480 (*May*, 1950) *In Russian.*

It is shown that the mechanism given by Neher and Pickering [*Phys. Rev.*, **53**, 316 (1938)] cannot be a correct description of the working of their quenching circuit. The demonstration is based on the proof that the quenching circuit represents an amplifier with cathode output, and not a resistance-quenching device. B. F. KRAUS (R)

537.542

8075. The control of a Wilson cloud chamber by means of an internal counter. A. L. Hodson, A. Loria and N. V. Ryder. *Phil. Mag.*, **41**, 826–37 (*Aug.*, 1950).

A technique is described for controlling a Wilson cloud chamber by an internal counter whose cathode consists of a hexagonal array of rods and whose sensitive volume is not separated from the main cloud chamber volume by any wall and in fact forms part of the usable chamber volume. The counter has no stopping power beyond that of the gas unless the incident particle chances to hit one of the rods. Events in which heavily ionizing particles are produced in the cloud chamber and events in which low energy particles traverse the chamber can thus be photographed. Discrimination between single fast particles or events of high ionization can be made at will. Altogether 26 slow particles (excluding electrons) have been photographed—corresponding to a vertical intensity of $9{\cdot}3 \times 10^{-5}$ slow particles $cm^{-2}\,min^{-1}$ $sterad^{-1}$ at sea level. Details of a proposed arrangement for photographing nuclear stars in the gas of the chamber are given. The technique is applicable to the study of the discharge phenomena of counters and some preliminary photographs of these phenomena are presented. The counter is quite stable and the technique of operation is not unduly difficult. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

8076. Mass spectra of diborane-d_6 and ethane-d_6. V. H. Dibeler, F. L. Mohler and L. Williamson. *J. Res. Nat. Bur. Stand., Wash.*, **44**, 489–94 (*May*, 1950).

The complete mass spectra of B_2D_6 and C_2D_6 and the partial spectrum of B_2D_5H have been obtained for ionizing voltages of 50 V and 70 V. An analytical procedure is given for deriving the contribution of all ions containing a H atom from the polyisotopic spectrum of a mixture of B_2D_6 and B_2D_5H. A comparison of spectra of B_2D_6 and B_2H_6 and of C_2D_6 and C_2H_6 indicates that substitution of D for H has only a slight effect on the dissociation probabilities in diborane and ethane. An exception is the occurrence of a metastable transition in B_2D_6 that does not occur in B_2H_6, viz. $B_2D_5^+ \rightarrow B_2D_3^+ + 2D$. Simple statistical considerations, based upon the assumption of equal probabilities for the removal of a deuterium

or a protium, give a dissociation pattern that differs by more than experimental error from that observed.

A.

537.562

8077. Detection of magnetic resonance by ion resonance absorption. H. SOMMER AND H. A. THOMAS. Letter in *Phys. Rev.*, **78**, 806 (*June* 15, 1950).

537.568 : 551.510.535

8078. The effective, noon recombination-coefficient of the F_2 layer deduced from critical frequency measurements during the Mögel–Dellinge effect on Nov. 19, 1949. W. BECKER AND W. DIEMINGER. *Z. Naturforsch.*, **5a**, 308–11 (*June*, 1950) *In German.*

Details are given of the measurements and of the method of deducing that the effective recombination coefficient of the F_2 layer at noon on the day concerned was not less than $1{\cdot}9\times10^{-10}$. W. J. G. BEYNON

537.568 : 551.510.535

8079. The recombination coefficient for the *F*-layer. M. W. JONES AND J. G. JONES. *Science*, **112**, 13–14 (*July* 7, 1950).

An expression is derived for the integrated recombination coefficient taken over region F_2 as a whole (assuming a parabolic ionization gradient). Sample monthly mean values of this quantity and of the recombination coefficient at the level of maximum electron density are given. W. J. G. BEYNON

537.581

8080. On some fundamental equations of the field theory of thermal emission. YU. A. SURINOV. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 3) 469–72 (1950) *In Russian.*

Several fundamental differential and integral equations of thermal emission are deduced for the case of a stationary system of emitting gray bodies separated by a diathermic medium. The emitting system is assumed to be a closed one, limited by a Lyapunov-type surface possessing an arbitrary configuration. It is also assumed that the fields of temperatures and of optical constants are continuous along the surface of the system. F. LACHMAN

537.583

8081. Use of titanium and zirconium nitrides as a conducting element in thoria cathodes. O. B. BUSH, R. B. VANDEGRIFT AND T. E. HANLEY. *J. Appl. Phys.*, **20**, 295–6 (*March*, 1949).

COSMIC RAYS 537.591

537.591.1

8082. On the origin of cosmic rays. A. EHMERT. *Phys. Bl.* (*No.* 5) 206–17 (1950) *In German.*

The experimental evidence concerning the primary radiation is reviewed, and an account is given of recent publications concerning the origin.

E. P. GEORGE

537.591.1

8083. On positive and negative excess of the penetrating component of cosmic radiation at 3 500 m above sea level. I. F. QUERCIA, B. RISPOLI AND S. SCIUTI. *Nuovo Cim.*, **7**, 277–80 (*May*, 1950).

Using an Fe-cored magnetic lens the +ve excess in the vertical direction at 3 500 m is found to agree with that previously found at 5 100 m and 7 300 m. Measurements at an inclination of 60° to the vertical show a −ve excess to the E (7·4%), and a +ve excess to the W (22·2%). The results can be explained either by assuming some −ve primary particles or by assuming bending of the secondary penetrating particles in the earth's field. E. P. GEORGE

537.591.1

8084. On the positive and negative excess of the penetrating component of cosmic radiation at 3 500 m above sea level. I. F. QUERCIA, B. RISPOLI AND S. SCIUTI. Letter in *Phys. Rev.*, **78**, 824–5 (*June* 15, 1950).

537.591.1

8085. A picture for cosmic-ray stars. Y. FUJIMOTO AND S. HAYAKAWA. Letter in *Progr. Theor. Phys.*, **5**, 315–16 (*March–April*, 1950).

The phenomenological division of star-producing nucleons into 3 categories, (A) $E_{kin} > 2$ BeV, (B) 2 BeV $> E_{kin} >$ 1 BeV, (C) 1 BeV $> E_{kin}$ is considered in terms of the probable star types produced and the n/p ratio of the nucleons. J. G. WILSON

537.591.1

8086. Diffusion of the nucleon component. Y. FUJIMOTO. Letter in *Progr. Theor. Phys.*, **5**, 316–17 (*March–April*, 1950).

The classification [see preceding Abstr.] is used to describe the diffusion of nucleons in the atmosphere. The large observed intensity of stars of (A) type nucleons in the stratosphere (45 g/cm²) throws doubt on existing estimates of primary cosmic-ray intensity.

J. G. WILSON

537.591.1

8087. On the primary cosmic ray spectrum. J. A. VAN ALLEN AND S. F. SINGER. Letter in *Phys. Rev.*, **78**, 819 (*June* 15, 1950).

Rocket determinations of primary intensity above the atmosphere and balloon data at great heights are collected for geomagnetic latitudes between 0° and 69° and the form of the primary spectrum investigated for momenta below 15 BeV/c. The differential spectrum over the range $2{\cdot}6 < p < 15$ BeV/c is well represented by a power spectrum of index 2·1; while at lower momenta the spectrum varies more slowly.

J. G. WILSON

537.591.1

8088. The proportion of cosmic ray tracks in Ilford (C3 + B) emulsion attributable to μ-mesons. H. MOUCHARAFYEH AND S. REBAUD. *C.R. Acad. Sci., Paris*, **230**, 2285–6 (*June* 26, 1950) *In French.*

There is uncertainty of identification of μ mesons in this emulsion near the lower limit of accepted grain density. In plates exposed at 4 500 m, 4°S geomagnetic, the energy spectrum of the particles other than mesons is examined in order to make the best estimate of the meson component in this energy range. Concluded that 2–3% of the tracks observed are those of μ-mesons. J. G. WILSON

537.591.1

8089. The origin of single cosmic ray protons. S. LATTIMORE. *Phil. Mag.*, **41**, 819–25 (*Aug.*, 1950).

The frequency of production, and the angular and energy distributions of single cosmic-ray protons

produced in photographic emulsions exposed at 3 650 m are given. It is shown that, after corrections for protons emitted from stars have been made, the results agree with those given in a previous paper [Abstr. 5535 (1949)]. The rates of production of fast protons in paraffin wax, C, Al and Pb are deduced from measurements of the number of protons observed to cross 100 μ C.2 emulsions surrounded completely by these materials. From the results for paraffin wax and C, the rate of production in H is also deduced. A.

537.591.1 : 539.18

8090. On nuclear disintegrations underground. C. Franzinetti. *Nuovo Cim.*, **7** (*No.* 3 *bis*) 384–7 (*May*, 1950).

Theoretical. Virtual π-mesons of nuclear fields are assumed to be ejected from nuclei by collision with energetic μ-mesons of the penetrating component. These knock-on π-mesons are assumed to be responsible for the nuclear disintegrations observed below ground. The calculated frequency of events is somewhat smaller than that observed. E. P. GEORGE

537.591.15

8091. A note on the size-frequency distribution of penetrating showers. A. Ramakrishnan. *Proc. Phys. Soc., Lond. A*, **63**, 861–3 (*Aug.*, 1950).

Heitler and Jánossy have calculated the probability that n mesons are produced due to nucleon–nucleon collisions by a fast nucleon in its passage through matter of a given thickness. In this note the results of Heitler and Jánossy are obtained by the direct method of writing the integro-differential equations of the problem using the Markoff nature of the process. A.

537.591.15

8092. The connection between electronuclear and narrow showers of cosmic rays. S. A. Dubrovina, M. P. Piskov and I. L. Rozental. *Dokl. Akad. Nauk, SSSR*, **71** (*No.* 6) 1049–52 (1950) *In Russian.*

4 banks of Pb-screened counters were hodoscoped, the master-pulse being provided by a coincidence in 3 small unscreened counters selecting dense air showers at 3 860 m. A large contribution to the frequency of master-pulses is shown to arise from back-ejected particles from penetrating showers produced in the Pb screens. The absorption of the particles of narrow air showers was studied, and examples of the production of electronuclear (mixed) showers by these particles are reported. E. P. GEORGE

537.591.15

8093. A remark on the transition curve of cosmic ray showers. J. Nishimura. Letter in *Progr. Theor. Phys.*, **5**, 328–9 (*March–April*, 1950).

537.591.15

8094. The electronic component in extensive air showers. Y. Fujimoto, S. Hayakawa and Y. Yamaguchi. *Progr. Theor. Phys.*, **5**, 196–206 (*March–April*, 1950).

The description of the density spectrum, altitude variation and directional distribution of extensive air showers is developed for the production of the initial cascade elements from proton primaries, and with particular reference to the charge exchange mechanism of photon production by colliding nucleons. It is concluded that these properties are better explained on the assumption of derivation from proton primaries than from primary electrons. J. G. WILSON

537.591.15

8095. Local air showers and bursts. R. Maze. *J. Phys. Radium*, **11**, 294–9 (*June*, 1950) *In French.*

Arrays of counters each surrounded with Pb shielding are used to show that the associated discharge of near shielded counters is mainly due to bursts originating in the shielding matter. Such bursts may discharge counters at distances up to 1 m. The mean free path of the burst primaries is measured, and found strongly energy sensitive. J. G. WILSON

537.591.15

8096. Properties of Rossi showers under thick absorbers. A. Fréon. *C.R. Acad. Sci., Paris*, **230**, 2178–80 (*June* 19, 1950) *In French.*

The Rossi shower curve has been determined at sea level and at 75 m water equivalent with particular reference to the plateau at thicknesses > 8 cm Pb and the nature of showers in this part of the curve. J. G. WILSON

537.591.15

8097. On the production of penetrating showers in lead and carbon. L. Mezzetti and R. Querzoli. Letter in *Phys. Rev.*, **79**, 168–9 (*July* 1, 1950).

537.591.15

8098. Transition effect of extensive and local penetrating cosmic-ray showers in Colombo. V. Appapillai and A. W. Mailvaganam. *Proc. Phys. Soc., Lond. A*, **63**, 856–61 (*Aug.*, 1950).

An account is given of the experiments on the transition effects of local and extensive penetrating cosmic-ray showers at Colombo (geomagnetic latitude 4° S). A comparison of the present results with those reported for higher latitudes indicates that there is no observable latitude effect of the local penetrating showers. Contrary to the findings of Broadbent and Jánossy, the transition effect of the extensive showers in paraffin appears comparable in magnitude with the effect in Pb. A.

537.591.15

8099. The density spectrum and structure of extensive cosmic-ray air showers at sea level. D. Broadbent, E. W. Kellermann and M. A. Hakeem. *Proc. Phys. Soc., Lond. A*, **63**, 864–83 (*Aug.*, 1950).

Showers have been examined in the density range 5–500 particles/m^2 using 2 trays of Geiger counters 5 m apart, the discharges of individual counters being recorded using neon lamps. The observed showers are compared with a theoretical analysis based on the usual assumptions that the incident densities are uniform over the extent of the apparatus and distributed according to the spectrum $N(x) = Bx^{-\gamma}$ per hr per m^2. The comparison shows (i) that in the density range examined the above spectrum applies only for a vanishingly small area of observation, with $\gamma = 1{\cdot}425 \pm 0{\cdot}022$, $B = 620$, and with no evidence for a change of γ with density, and (ii) that for the separation of 5 m employed, the density cannot be regarded as uniform over the extent of the apparatus. It is shown that this second conclusion is capable of

explaining many of the differences found between the results of other authors obtained on the assumption of uniformity of density: in particular, it is concluded that there is yet no significant evidence for a change of γ with altitude. A.

537.591.2

8100. Mass determination on cosmic ray particles at 3 650 m altitude. E. Bastin, J. Becker, P. Chanson, E. Nageotte and P. Treille. *J. Phys. Radium*, **11**, 273–83 (*June*, 1950) *In French.*

The deduction of mass from the momentum measured in a cloud chamber with magnetic field, and the range measured by the subsequent penetration of a succession of Cu screens, is discussed in detail. Measurements indicate that at 3 650 m the intensity of particles, 220 MeV/$c < p <$ 550 MeV/c, with mass between 500 and 1 100 m_0 and lifetime $> 10^{-9}$ sec, cannot exceed 5×10^{-5} cm^{-2} sec^{-1} sterad^{-1}. The mass limits are those set by precision of experiment, and this intensity is considered to refer to all particles intermediate between π-mesons and protons.

J. G. WILSON

537.591.3

8101. On some photon radiation observed by measurements of cosmic rays at great depths. M. Miesowicz, L. Jurkiewicz and J. M. Massalski. *Acta Phys. Polon.*, **10** (*No.* 1–2) 69–78 (1950).

The non-ionizing radiation noted by Barnothy and Forro [Abstr. 1089 (1949)] has been investigated at a depth of about 600 m.w.e. The radiation is shown to be isotropic with an absorption coefficient of about 1·4 cm^{-1} Pb, and is identified as a γ-radiation, probably from natural radioactive sources.

J. G. WILSON

537.591.3

8102. Energy loss of fast charged particles in a completely ionized medium (ionic plasma). Application to cosmic rays travelling in interstellar space. B. Kwal. *C.R. Acad. Sci., Paris*, **230**, 1662–4 (*May* 8, 1950) *In French.*

Theoretical. The ionization loss in an ionic plasma is much greater than in media composed of atoms in the normal state, due to the removal of the usual low and high frequency limits established by electron binding, and screening, respectively. A formula is given for the energy loss in ionic plasma. Numerical values are given for a plasma containing 1 electron and 1 proton cm^3 (a model of interstellar space), the energy losses are about 40 > in atomic H. These losses are > those allowed by Fermi, and provide additional difficulties for his theory of the origin of cosmic-rays. E. P. GEORGE

537.591.5

8103. Contributions to the theory of the latitude effect and zenith angle asymmetry of cosmic rays: the penumbra near the equator. R. de Vogelaere. *Ann. Soc. Sci. Brux.*, **64** (*No.* 1–2) 83–92 (1950) *In French.*

537.591.5

8104. The East-West effect of the cosmic-ray in the upper atmosphere. S. Ogawa and Y. Nagahara. Letter in *Progr. Theor. Phys.*, **5**, 313 (*March–April*, 1950).

537.591.5

8105. The production of coherent penetrating particles in the atmosphere. J. Clay and E. van Alphen. *Physica*, **16**, 393–6 (*April*, 1950).

A penetrating shower counter array of 3 layers, $3 \times 2 = 6$ fold coincidences being recorded, and 10 cm Pb shielding between 2 lower trays only, was operated at sea level, 3 040 m and 7 000 m. While this apparatus yields the barometric coefficient, 15%/cm Hg at sea level, the change of rate with altitude is not exponential with mass of air but increases more rapidly at the greater altitude.

J. G. WILSON

537.591.5

8106. Zenith angle distribution of penetrating cosmic ray particles in a selected low energy band. A. Rogozinski and A. Voisin. *C.R. Acad. Sci., Paris*, **230**, 2092–4 (*June* 12, 1950) *In French.*

The zenith angle distribution at altitudes 150 m and 2 870 m of particles which do not produce showers and are of range between 14 cm and 22 cm Pb cannot be represented by a cosine law of constant index. It is suggested that phenomena are involved which make a significant contribution only at large zenith angles. J. G. WILSON

537.591.5

8107. On the azimuthal asymmetry of cosmic-ray intensity above the atmosphere at the geomagnetic equator. J. A. van Allen and A. V. Gangnes. *Phys. Rev.*, **79**, 51–3 (*July* 1, 1950).

By means of G.M. tube telescopes in an Aerobee sounding rocket fired to high altitude at the geomagnetic equator, information on the azimuthal asymmetry of the cosmic-ray intensity above the atmosphere has been obtained. These results, in conjunction with previously reported vertical intensities and specific ionizations at $\lambda = 0°$ and $\lambda = 41°$ N, are consistent with the hypothesis that most of the primaries are positively charged protons with differential number spectrum of the form $dN = KE^{-1\cdot9}dE$ in the energy region 5 to 23 BeV. A.

537.591.5

8108. Latitude effects for stars. I. Production rates and prong distributions. II. Shower particles. E. O. Salant, J. Hornbostel, C. B. Fisk and J. E. Smith. Letters in *Phys. Rev.*, **79**, 184–5 (*July* 1, 1950).

537.591.5 : 539.185

8109. Balloon-borne instrumentation for neutron detection. M. Pavalow, W. O. Davis and W. P. Staker. *Rev. Sci. Instrum.*, **21**, 529–33 (*June*, 1950).

A description is given of balloon-borne proportional counters and circuitry for telemetering and recording cosmic-ray neutron intensities. The preamplifier, amplifier, scaler and trigger circuit described all use low drain directly heated battery-type tubes. Methods and reasons for pressurization of high voltage circuits are discussed. Included is a description of a multiple-level flight technique using single large plastic balloons for long time intervals at pre-set altitudes. A.

537.591.8

8110. Stars and heavy primaries recorded during a V-2 rocket flight. H. Yagoda, H. G. de Carvalho and N. Kaplan. *Phys. Rev.*, **78**, 765–7 (*June* 15, 1950).

Plates flown to an altitude of 150·7 km in a V-2 rocket exhibit a differential star population of

5 000 ± 800 per cc. per day and a flux of heavy primaries of about 0·03 per cm² per min above the stratosphere. The star intensity is about 3·6 times greater than that recorded by plates exposed in the stratosphere, the increment being attributable to secondary star forming radiations created by interaction of cosmic-ray primaries with the massive projectile. The flux of heavy primaries is essentially of the same order of magnitude as reported for elevations of 28 km. A.

537.591.8

8111. Meson formation in cosmic rays. M. TEUCHER. *Naturwissenschaften*, **37** (*No.* 11) 260–2 (1950) *In German.*

A nuclear encounter in Ilford G5 emulsion at 2 963 m altitude contains no tracks of slow nucleons. It is interpreted as the collision of a primary proton with a hydrogen nucleus. J. G. WILSON

537.591.8

8112. Gap measurement as a method of analysing cosmic ray stars in emulsions. P. E. HODGSON. Letter in *Phil. Mag.*, **41**, 725–9 (*July*, 1950).

Observations on particle tracks are recorded in which the gaps in the tracks, rather than the grains, are measured. This renders possible reliable discrimination between α-particles, protons and mesons at low energies in electron-sensitive plates, where the normal methods are unreliable due to excessive clogging. E. P. GEORGE

MAGNETISM 538

538.082.74 : 537.533.72

8113. The measurement of the magnetic field in a nuclear spectrometer. L. M. LANGER AND F. R. SCOTT. *Rev. Sci. Instrum.*, **21**, 522–3 (*June*, 1950).

An arrangement is described which gives a continuous measurement of the relative magnetic field strength in a nuclear spectrometer with an accuracy of about 0·1%. The method consists of balancing the a.c. voltage picked up by a coil rotating in the field of the spectrometer against that picked up in a standard Helmholtz field. A.

538.114

8114. Antiferromagnetism. Theory of superexchange interaction. P. W. ANDERSON. *Phys. Rev.*, **79**, 350–6 (*July* 15, 1950).

In this paper the general formalism of Kramers indicating the existence of superexchange interaction has been reduced, under simplifying assumptions, to the point where actual formulas for the interaction can be written down directly in terms of spin operators, with certain exchange and transition integrals as parameters. Two results of physical interest are the following: (*a*) superexchange must be expected to show the directional properties (as far as directional relations of interacting magnetic ions are concerned) of the orbitals in the outer shell of the non-magnetic connecting ions; and (*b*) the sign of the effective exchange integral depends upon the sign of the internal exchange coupling of an added electron on the magnetic ion. A.

538.114 : 530.162

8115. Antiferromagnetism. The triangular Ising net. G. H. WANNIER. *Phys. Rev.*, **79**, 357–64 (*July* 15, 1950).

In this paper the statistical mechanics of a two-dimensionally infinite set of Ising spins is worked out for the case in which they form either a triangular or a honeycomb arrangement. Results for the honeycomb and the ferromagnetic triangular net differ little from the published ones for the square net (Curie point with logarithmically infinite specific heat). The triangular net with antiferromagnetic interaction is a sample case of antiferromagnetism in a non-fitting lattice. The binding energy comes out to be only one-third of what it is in the ferromagnetic case. The entropy at absolute zero is finite; it equals

$$S(0) = R\frac{2}{\pi}\int_0^{\pi/3} \ln(2\cos\omega)d\omega = 0{\cdot}3383R.$$

The system is disordered at all temperatures and possesses no Curie point. A.

538.114 : 530.162

8116. Statistical mechanics of the two-dimensional assembly. H. N. V. TEMPERLEY. *Proc. Roy. Soc. A*, **203**, 202–7 (*July* 7, 1950).

The work of Kaufman and Onsager [Abstr. 3928 (1950)] on the two-dimensional Ising model of a ferromagnet is extended from the plane square lattice to the plane honeycomb and triangular lattices. The specific heat anomaly, where it exists, turns out to be of the same type in all three lattices, an infinity in the specific heat at the Curie temperature. It is concluded that second-nearest neighbour interactions may have a considerable effect on the position of the Curie temperature. A.

538.114 : 530.162

8117. Statistics of the three-dimensional ferromagnet. I. T. OGUCHI. *J. Phys. Soc. Japan*, **5**, 75–81 (*March–April*, 1950).

A detailed account of theoretical work previously summarized in *Physical Review* [Abstr. 1068 (1950)]. E. P. WOHLFARTH

538.13 : 621.314.2.042.2 : 621.3.013.1

8118. On the theory of magnetically inhomogeneous surface layers in transformer laminations. R. FELDTKELLER. *Frequenz*, **4**, 129–34 (*June*, 1950) *In German.*

Transformer laminations are found to possess a surface skin in which the local permeability varies markedly with distance from the outer surface. The effect of eddy currents on the local permeability on the inside of the lamination is calculated for frequencies at which the entire flux is confined to the inhomogeneous region. The surface permeability is assumed to have a finite value and the permeability may either rise or fall towards the middle of the section. Calculations are based on the equations for a Bessel line and the appropriate functions are graphed and adequately discussed. S. C. DUNN

538.214

8119. Diamagnetic susceptibility of cadmium ion. M. PRASAD, S. S. DHARMATTI, C. R. KANEKAR AND R. A. BHOBE. *Proc. Indian Acad. Sci. A*, **31**, 289–99 (*May*, 1950).

The magnetic susceptibility of a number of Cd salts

of inorganic and organic acids have been measured on the modified form of Gouy's balance. The susceptibility of the Cd ion has been deduced by the statistical method both from salts of inorganic acids and organic acids; the mean value of the ion obtained from the latter type of salts is significantly higher than that obtained from the former type. From the χm-N graphs, the susceptibility values of anions and Cd ion in combination with these anions have been determined. The values for the susceptibility of Cd ion have been calculated in two ways: (i) by multiplying the slopes of the straight lines obtained by plotting χm-N graphs, by the number of electrons in the Cd ion, and (ii) by subtracting the values of the anions (obtained from the intercepts) from the molecular susceptibilities of Cd salts. The former values are more correct. The susceptibility of Cd ion obtained graphically from various salts of inorganic acids is fairly constant but varies in combination with organic anions. Ionic radius of Cd has been calculated from the average values for the susceptibility of the ion from salts of inorganic and organic acids. A.

538.214

8120. Magnetic susceptibility of αFe_2O_3 and αFe_2O_3 with added titanium. F. J. Morin. Letter in *Phys. Rev.*, **78**, 819–20 (*June* 15, 1950).

538.22

8121. Crystal orientation in iron-silicon transformer sheets and its relation to the magnetic properties and heat treatment. Preliminary investigation. L. E. R. Rogers. *Rep. Brit. Elect. Res. Ass.* (*Ref. N/T38*) 13 *pp* (1950).

The sheets (2% Si) were prepared by cold rolling, with only one intermediate anneal in H_2, and the following conclusions were reached: There is little correlation between hysteresis loss and crystal orientation. A reduction of ca. 10% after the intermediate anneal slightly decreases the loss. Good magnetic properties may be obtained even with fairly impure starting materials. The loss is increased if the specimens are allowed to bend during the final anneal. The specific resistance and magnetic properties are not directly related; the resistance depends mainly on the final annealing temperature. The experimental results are presented fully in tables and graphs; some pole figures, showing orientation, are given. E. P. WOHLFARTH

538.222

8122. An oscillographic method for observing magnetic resonance spectra. R. Malvano and M. Panetti. Letter in *Phys. Rev.*, **78**, 826–7 (*June* 15, 1950).

538.222 : 539.152.2

8123. Nuclear resonance and magnetic field changes of 1 in 10^6. J. S. Gooden. Letter in *Nature, Lond.*, **165**, 1014–15 (*June* 24, 1950).

In the nuclear magnetic resonance of water solutions the rate of decay of the "wiggles" is measured from the amplitudes at a definite field strength on the forward and return phases of the 50 c/s oscillating field. This decay rate is independent of the spatial inhomogeneity of the static magnetic field, but depends on the relaxation times of the material and increases with the radio-frequency field strength. Sudden changes of 1 in 10^6 in the static field distur the wiggles pattern noticeably. D. H. WHIFFE

538.23 : 548.3

8124. Torque-angle curves for a single-crystal dis of an iron-silicon alloy. D. Shoenberg and A. J. C Wilson. *Rep. Brit. Elect. Res. Ass.* (*Ref. No. N/T3* 22 *pp.* (1946).

The torque produced by a magnetic field applie in the plane of a single-crystal disc of 2·1% silico iron has been measured for various fields as a functio of the angle, θ, between the field and the [100 direction. The plane of the disc was approximatel [01$\bar{1}$]. At low fields the torque is proportional t $\sin 2\theta$, indicating that there is a tendency for th magnetic domains to be magnetized parallel to th $\pm$[100] directions, which lie nearly in the plane c the disc, rather than the $\pm$[010] or $\pm$[001] direction which make angles of 45° with the plane of the disc The torque measurements thus provide direct evidenc for a preference previously postulated to account fc the apparent anisotropy of the initial permeabilit and certain other effects. At higher fields the natu of the torque-angle curve changes, the torque becom ing zero for the applied field parallel to [111], as we as for the field parallel to [100] and [011]. Th change is comparatively sudden, and takes place fc $I/I_{sat} \sim 0{\cdot}6$. This is approximately the intensity c magnetization for which the direction of magnetiz tion of the magnetic domains begins to leave th direction of easiest magnetization and turn towar the field direction. At low fields the rotationa hysteresis has its greatest negative value for th applied field parallel to [100], and its least negativ value for the field parallel to [011]. At higher field the least negative value occurs for the field paralle to [111]; both [100] and [011] are maxima. Th rotational hysteresis loss per cycle is of the sam order of magnitude as the alternating hysteresis los per cycle for the same polarization, and is in fa fairly close to the mean of the alternating losses fc the [100], [111] and [011] directions.

538.2

8125. Large Barkhausen discontinuities. III. Grow and disappearance of nuclei of reversed magnetizatio S. Ogawa. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A* **1**, 53–62 (*May*, 1949) *In German.*

The nuclei are formed, and their dimension measured, in an Fe–Ni–Co alloy under extern tension and for different values of the applied fiel The general character of the results is in good agre ment with Döring's treatment; the observed values c the critical field strength, H_0, and the boundar energy, γ, agree well with those estimated theoreticall The relation between growth of nuclei and doma boundary movement is discussed qualitatively.

E. P. WOHLFART

538.2

8126. On the displacement velocity of a magnet domain boundary by a large Barkhausen jump in ferromagnetic substance. T. Huzimura. *J. Phy Soc. Japan*, **5**, 56–60 (*March–April*, 1950).

Experiments on Fe–Ni–Co alloy specimens different temperatures indicate that the Sixtus–Tonk formula is here not obeyed; it is suggested that th influence of eddy currents is of minor importance

determining the displacement velocity compared with a mechanism proposed by Katayama and Tsuya [Abstr. 6322 (1949), 5146 (1950)], in which the energy loss during displacement is governed by direct exchange between the electron spin and the crystal lattice. E. P. WOHLFARTH

538.24

8127. Ferromagnetic resonance in manganese ferrite and the theory of the ferrites. C. GUILLAUD, W. A. YAGER, F. R. MERRITT AND C. KITTEL. Letter in *Phys. Rev.*, **79**, 181 (*July* 1, 1950).

538.245

8128. Energies and widths of domain boundaries in ferromagnetics. B. A. LILLEY. *Phil. Mag.*, **41**, 792–813 (*Aug.*, 1950).

A systematic treatment is given of the energies and widths of domain boundaries in ferromagnetics; it covers cubic crystals, with positive or negative magneto-crystalline anisotropy coefficients, and crystals with a single easy direction of magnetization. This extends the investigations of Bloch (1932), Landau and Lifshitz (1935), Lifshitz (1944) and Néel (1944) on Co and Fe, and enables estimates to be made of the energies and widths of domain boundaries in Ni. The effect of magneto-elastic anisotropy energy is considered. Theoretical values of the energies and widths of the more important types of boundary in Ni, Fe and Co are calculated. A.

538.245

8129. Magnetization curves for polycrystalline ferromagnetics. H. LAWTON AND K. H. STEWART. *Proc. Phys. Soc., Lond. A*, **63**, 848–51 (*Aug.*, 1950).

Recently described developments have led to greatly improved agreement between theory and experiment for the magnetization curves of single crystals of Fe and Fe–Si in the region where magnetization proceeds by rotation of domain vectors against the action of magnetocrystalline forces, i.e. in the range 10–500 oersteds. On the basis of the assumption that in polycrystalline material the magnetization is approximately uniform from grain to grain, which is rendered plausible by consideration of internal demagnetizing effects, a method is developed for deriving the magnetization curves of such material by averaging the fields required to produce a given magnetization in the different constituent grains, rather than by averaging the magnetizations produced in the different grains by a given field. The application of this method to specimens with known distributions of grain orientations is shown to give results in fair agreement with experiment. A.

538.245 : 538.69 : 621.3.017.39 : 621.318.321

8130. Gyromagnetic phenomena occurring with ferrites. H. G. BELTERS AND J. L. SNOEK. *Philips Tech. Rev.*, **11**, 313–22 (*May*, 1950).

The material "Ferroxcube" is characterized by very low eddy-current and hysteresis losses. In the frequency range of 0–10^5 c/s some after-effect is observed. Above a certain critical frequency, differing between one material and another, additional losses occur which may be ascribed to gyromagnetic resonance. The theory of this phenomenon is explained with the aid of a mechanical model. Further, measurements of the gyromagnetic resonance are described which have been carried out with a material placed in a constant, strong magnetic field polarizing the material in a direction perpendicular to the direction of observation. These measurements confirm in the main the theoretical expectation. It is indicated briefly how the losses observed can be explained qualitatively from the gyromagnetic phenomena. Finally it is pointed out that with the aid of gyromagnetic effect a quadripole with new properties (a gyrator) can be constructed. [See Abstr. 2804 (1948)]. A.

538.248

8131. On the decrease of the thermoremanent and isothermal remanent magnetizations of baked clays by the action of increasing opposed fields. J. ROQUET. *C.R. Acad. Sci., Paris*, **230**, 1939–41 (*May* 31, 1950) *In French.*

Describes the decrease of these magnetizations, already studied from other points of view [see Abstr. 2583 (1950)], due to magnetic fields opposed to the initial magnetizing field. The fields required to reduce these magnetizations to zero attain high values: 7 650 oersteds maximum. H. P. MYERS

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.521 : 621.318.2.018.44

8132. Distribution of magnetic induction over the thickness of a ferromagnetic ring placed in an alternating electromagnetic field. S. D. MARGOLIN. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 3) 493–5 (1950) *In Russian.*

Experiments on 5 mm thick 20 cm o.d. 14 cm i.d. ring with search coils of diminishing areas distributed uniformly over the circumference, and with magnetizing coils connected to a source of sinusoidal a.c., have given results in agreement with theoretical formulae published in the *J. Tech. Phys., USSR*, **18**, 1306–16 (*Oct.*, 1948). [Abstr. 2096B (1949)].

J. LUKASZEWICZ

538.522

8133. Self- and mutual inductance of a metal spherical shell and of an infinite solenoid [enclosing the sphere]. A. COLOMBANI. *C.R. Acad. Sci., Paris*, **230**, 2158–60 (*June* 19, 1950) *In French.*

It is shown that the resistance of the spherical shell is $2\pi/3\gamma e$, its self-inductance $8\pi^2 a/9$, the coefficient of mutual inductance between the shell and the inducing solenoid $\frac{8}{3}\pi^2 n a^2[1 + 9\varepsilon^4/4a^2e^2]^{\frac{1}{2}}$, the increase of resistance of the solenoid $48\pi^2 n^2 \omega a^4 \varepsilon^2 e/(4a^2e^2 + 9\varepsilon^4)$ and that of its self-inductance $32\pi^2 n^2 a^3 e^2/(4a^2e^2 + 9\varepsilon^4)$. ($\gamma$ = conductivity of the metal, e = thickness of the shell, a = radius of sphere, n = number of turns/cm of the solenoid, $\varepsilon^2 = 1/2\pi\omega\gamma$). L. PINCHERLE

538.56

8134. Outline of a mathematical theory of electromagnetic oscillations. C. MÜLLER. *Arch. Math.*, **1**, 296–302 (1949) *In German.*

The existence and uniqueness of solutions of Maxwell's equations are discussed when the specific

inductive capacity, ε, and the magnetic permeability, μ, are functions of position. Four cases are considered: (1) $\varepsilon = \text{const.}$, $\mu = \text{const.}$, (2) ε and μ are differentiable functions and grad $\varepsilon = \text{grad}\,\mu = 0$ outside V (a given finite closed region), (3) ε and μ have constant values both inside and outside V, but these values change abruptly on the surface of V, (4) case (3) with ε infinite within V.

MATHEMATICAL REVIEWS

538.566

8135. Effective cross-section of metal screens. G. Toraldo Di Francia. *Atti Accad. Naz. Lincei (R.C.Cl. Sci. Fis. Mat. Nat.)* **8,** 369–73 (*April,* 1950) *In Italian.*

An application of the method of treating diffraction problems first introduced by Schwinger. A rigorous proof is given of the relation $\sigma = -\lambda Im\, E_d$, where σ is the transmission cross-section—in the direction of the normal to the incident plane wave—of an opening in a perfectly conducting plane screen, and Im E_d the imaginary part of the complex electric amplitude diffracted in the same direction (and with the same polarization of the incident wave). It is also shown that the effective cross-section of a plane metal screen of any shape for a plane wave W_1 of a given polarization is equal to twice the transmission cross-section of the complementary screen for a wave W_2 polarized perpendicularly to W_1. L. PINCHERLE

538.566 : 621.396.11 : 621.396.9

8136. Radiation reflected from bodies in undulatory fields. C. L. Kober. *Öst. Ingen. Arch.,* **4** (*No.* 3–4) 235–43 (1950) *In German.*

All methods of calculation based on the laws of diffraction fail to give satisfaction unless the bodies are of simple geometrical shape. The methods of thermodynamical optics are used to develop a Fourier integral, the properties of which lead to the notion of the optical degree of freedom as applied to reflected radiation. It is thus possible not only to describe reflected radiation exactly and to develop formulas concerning the active range of a radar station in regard to specified targets, but also to solve farther-reaching problems such as the determination of the natural frequency (period of natural vibration) for cavities of any shape, as well as the development of formulae concerning the acoustic and electric echoes in them. The essential feature of this treatise consists in the introduction of a substantially novel method which permits of calculating by asymptotic approximation the reflection and diffraction phenomena in case of reflecting bodies of intricate geometrical shapes. A.

538.566.2 : 621.396.11

8137. On the propagation of electromagnetic waves in an atmospheric waveguide. T. Kahan and G. Eckart. *Z. Naturforsch.,* **5a,** 334–42 (*June,* 1950) *In German.*

The mathematical theory and physical phenomena of e.m. wave propagation in an atmospheric "duct" are considered. W. J. G. BEYNON

538.566.3 : 551.510.535

8138. Higher-order approximations in ionospheric wave-propagation. J. Feinstein. *J. Geophys. Res.,* **55,** 161–70 (*June,* 1950).

It is found that the ionosphere, even when considered homogeneous, is a linear medium for the propagation of electromagnetic waves only as a first approximation. Second-order terms give rise to harmonics, and to sum and difference frequencies when two independent waves traverse the same physical region. These new frequencies are, in general, of the nature of forced vibrations, except in the cases where their propagation characteristics are those of a natural mode capable of existing in the region. A resonance effect then occurs, the new wave increasing its energy at the expense of the interacting waves and assuming an independent existence. While these effects couple energy from the primary wave, they do not affect its propagation characteristics. As a result of the degeneracy of the determinantal equation for the propagation constant, the introduction of any disturbing physical effects, such as a layer drift velocity, raises the degree of the equation, resulting not merely in changes in the values of the propagation constants of the usual modes, but, in addition, introducing new ones. For the usual disturbing effects encountered in the ionosphere, the energy content of these new modes is negligibly small. A

538.566.3 : 551.510.535 : 621.396.11

8139. Effect of a sudden ionospheric disturbance on long radio waves reflected obliquely from the ionosphere. K. Weeks. Letter in *Nature, Lond.,* **165,** 935–6 (*June* 10, 1950).

Note on some radio experiments which indicate that a sudden ionospheric disturbance increases the amplitude of the reflected signal in the case of 100 kc/s waves transmitted over a distance of 900 km, but decreases the amplitude for signals of the same frequency incident less obliquely on the ionosphere. W. J. G. BEYNON

538.566.3 : 621.396.11

8140. Ionospheric cross-modulation: techniques of measurement. C. C. Newton, F. J. Hyde and H. G. Foster. *Proc. Phys. Soc., Lond. B,* **63,** 616–23 (*Aug.* 1950).

MAGNETIC EFFECTS 538.6

538.6

8141. Magnetic rotatory power in solutions and its temperature variation. M.-C. Ollivier. *C.R. Acad. Sci., Paris,* **230,** 2172–4 (*June* 19, 1950) *In French.*

The angle of rotation θ was represented by $\theta = a - bT + Y(T)$ and Y measured for Ce and Pr nitrates and several double salts of the form $2(NO_3)_3Ce, 3(NO_3)_2M \cdot 24H_2O$ with M = Ni, Mn, Mg, etc. The $Y(T)$ curves show discontinuities in slope at a number of temperatures; for the double salts θ obeys an additivity law at different temperatures. E. P. WOHLFARTH

538.61

8142. Rotary magnetic polarization—on the constancy of the rotation in the fluid state. R. De Mallemann. *C.R. Acad. Sci., Paris,* **231,** 92–(*July* 10, 1950) *In French.*

The variations of the specific rotation and the rotativity as a function of temperature are considered, tables being given which show that the rotativity is sensibly independant of the temperatur

of the liquid, and has also the same value for a substance in the molten state or in benzene solution at ordinary temps. The specific rotation shows considerably greater variations under these conditions. G. F. HODSMAN

538.632 : 537.311.33

8143. On the theory of the Hall effect for the case of mixed conductors in an alternating magnetic field. H. WELKER. *Onde Elect.*, **30**, 309–16 (*July*, 1950) *In French.*

Formulae are developed for the effect in mixed conductors, i.e. in which simultaneous electron and hole conduction, intrinsic plus impurity conduction, and ionic conduction and conduction in polyvalent metals, takes place. The magnitude of the Hall e.m.f. is found to vary with the frequency of the applied field. This work is consistent with ideas on transistor action developed by Bardeen, Brattain and Shockley. C. A. HOGARTH

538.652 : 534.232 : 621.318.3

8144. Evaluation of the magnetostrictive properties of Hiperco. H. SUSSMAN AND S. L. EHRLICH. *J. Acoust. Soc. Amer.*, **22**, 499–506 (*July*, 1950).

The magnetostrictive properties of Hiperco, a magnetic alloy of Fe, Co, and Cr, were investigated to determine its suitability as a material for electromechanical transducers. The relations between the magnetic and magnetostrictive characteristics of a material and its performance as a transducer element are reviewed and criteria for its evaluation established. The properties of Hiperco, measured after a suitable heat treatment had been determined, are discussed in relation to these criteria and a comparison is made with Ni and Permendur. For operation at magnetic remanence Hiperco is shown to be as good as Permendur for hydrophone applications, but inferior to Ni and Permendur when used as an underwater projector at high power levels. When polarized above remanence a maximum value of 0·17 for the electromechanical coupling coefficient is realized and operation as a projector is improved. Performance data are given for a small underwater transducer constructed of Hiperco operating at remanence. A.

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

8145. A simplified method of computing the cohesive energies of monovalent metals. T. S. KUHN AND J. H. VAN VLECK. *Phys. Rev.*, **79**, 382–8 (*July* 15, 1950).

A method is developed which, within the limits of the spherical cell approximation first presented by Wigner and Seitz, permits the evaluation of the cohesive energy, lattice constant and compressibility without the explicit computation of a central field for the atom. It is shown that empirical values of the first few *s* and *p* levels of the free atom can supply the relevant information usually obtained through the computation of a central field, so that a considerable simplification is possible. The method is applied to the calculation of the usual solid state parameters for the alkali metals, Na, K and Rb. The results for Na compare very favourably with experiment as well as with those gained by previous workers. The K and Rb computations agree decidedly less well with experiment, but the values for K are appreciably better than those previously computed utilizing an explicit central field. The errors shown by the K and Rb computations are believed to be the inevitable consequence of any theory derived by replacing the effect of the core electrons by an equivalent central field rather than a result of any peculiarities inherent in the present approach. A.

539.11 : 669

8146. Atomic space-lattice and the metallic state. T. A. HOFFMANN. Letter in *J. Chem. Phys.*, **18**, 989–90 (*July*, 1950).

MOLECULAR STRUCTURE 539.13

539.13 : 539.27

8147. Internal motion and molecular structure studies by electron diffraction. II. Interpretation and method. J. KARLE AND I. L. KARLE. *J. Chem. Phys.*, **18**, 957–62 (*July*, 1950).

The application of a recently developed objective procedure to the analysis of electron diffraction photographs from more complex molecules [Abstr. 2035 (1950)] is discussed in terms of the further development of the details of some of the theoretical and experimental aspects of the procedure. The topics discussed are the physical significance of measured vibrational amplitudes, the method for drawing a background line, the calibration of photographic plates, and the computation of intensity curves by means of IBM machines. A.

539.13 : 539.27

8148. Internal motion and molecular structure studies by electron diffraction. III. Structure of CH_2CF_2 and CF_2CF_2. I. L. KARLE AND J. KARLE. *J. Chem. Phys.*, **18**, 963–71 (*July*, 1950).

The interatomic distances and vibrational amplitudes projected on the lines connecting pairs of atoms at equilibrium have been determined for CH_2CF_2 and CF_2CF_2 by an objective procedure for analysing electron diffraction photographs (see preceding Abstr.) Distances involving H atoms have been evaluated and the procedure for resolving radial distribution peaks involving more than one distance is illustrated. The effects on the accuracy of the method of various characteristics such as sample spread and multiple scattering have been analysed. A.

539.132

8149. Electronic levels in simple conjugated systems. I. Configuration interaction in cyclobutadiene. D. P. CRAIG. *Proc. Roy. Soc. A*, **202**, 498–506 (*Aug.* 22, 1950).

In the simplest cyclic system of π-electrons, cyclobutadiene, a non-empirical calculation has been

made of the effects of configuration interaction within a complete basis of antisymmetric molecular orbital configurations. The molecular orbitals are made up from atomic wave functions and all the interelectron repulsion integrals which arise are included, although those of them which are 3- and 4-centre integrals are only known approximately. In this system configuration interaction is a large effect with a strongly differential action between states of different symmetry properties. Thus the $^1A_{1g}$ state is several electron-volts lower than the lowest configuration of that symmetry, whereas for $^1B_{1g}$ the comparable figure is about one-tenth of an electron-volt. The other two states examined, $^1B_{2g}$ and $^3A_{2g}$, are affected by intermediate amounts. The result is a drastic change in the energy-level scheme compared with that based on configuration wave functions. Neither the valence-bond theory nor the molecular orbital theory (in which the 4 states have the same energy) gives a satisfactory account of the energy levels according to these results. One conclusion from the valence-bond theory which is, however, confirmed, is the somewhat unexpected one that the non-totally symmetrical $^1B_{2g}$ state is more stable than the totally symmetrical $^1A_{1g}$. On the other hand, it is clear that the valence-bond theory, with the usual value for its exchange integral, grossly exaggerates the resonance splitting of the states, giving separations between them several times too great. Thus the valence-bond theory leads to large values of the resonance energy (larger, per π-electron, than in benzene) and so associates with the molecule a considerable π-electron stabilization. This expectation has no support in the present more detailed and non-empirical calculations. A.

539.132

8150. A correlation of restoring coefficients in molecular potential functions and bond orders between the different atoms in polyatomic molecules. A. LANGSETH AND C. K. MØLLER. Letter in *Nature, Lond.*, **166**, 147–8 (*July* 22, 1950).

539.132

8151. Oscillator strength of the Na_2 $^1\Sigma$—$^1\Sigma$ transition. G. STEPHENSON. Letter in *Nature, Lond.*, **166**, 191–2 (*July* 29, 1950).

539.132 : 535.343–15

8152. Vibrational intensities. I. Theory of diatomic infra-red bands. B. L. CRAWFORD, JR., AND H. L. DINSMORE. *J. Chem. Phys.*, **18**, 983–7 (*July*, 1950).

A rigorous treatment of the intensities of vibration-rotation absorption spectra of diatomic molecules is given, leading to explicit expressions relating the observed intensities of the fundamental and first two overtones to the appropriate coefficients in the expansions of the potential energy and the dipole moment. A.

539.132 : 535.56

The molecular anisotropy of natural rotatory power. *See Abstr.* 7924–5

539.132 : 541.57

8153. The electronic structure and the bond lengths of ovalene. A. J. BUZEMAN. *Proc. Phys. Soc., Lond. A*, **63**, 827–9 (*Aug.*, 1950)

The method of molecular orbitals has been applied to find the bond orders and the bond lengths c ovalene, $C_{32}H_{14}$. A comparison with the preliminar experimental values of Donaldson and Robertso shows general agreement. A

539.132 : 541.5

The logical position of the "dissociation energy of bond." *See Abstr.* 8306

539.132 : 541.5

The electron affinities of some aromatic molecule *See Abstr.* 8307

539.13

8154. The planar vibrations of tetra-chloro-ethylen an example of a complete normal coordinate analysi P. TORKINGTON. *Proc. Phys. Soc., Lond. A*, **63**, 804–2 (*Aug.*, 1950).

For the B_{1g}, B_{2u} and B_{3u} modes the analysis complete, including the calculation of the coefficien in the transformation to normal coordinates, th components in the displacements, the directions c the displacement vectors and the distribution of th potential energy, as well as the force constants, fc a range of solutions; in each case, 2 alternativ assignments are employed. For the A_g vibration several ranges of possible solutions are obtaine Curves are given in every case, and corrections fc variable structural parameters calculated for selecte solutions. The results for the various symmetr classes are discussed and correlated, and the mos likely set of force constants in the valence-forc potential function deduced. Details of the metho of analysis are given. A

539.13

8155. Prediction of interatomic distances and forc constants in diatomic hydrides. J. R. PLATT. *J. Chem Phys.*, **18**, 932–5 (*July*, 1950).

The interatomic distance in hydrides is roughl the radius in the united atom at which $Z_{\text{eff}} = 1·6$ The force constant is roughly $4\pi\rho e^2$ where ρ is th electron density at this radius. These results a justified by a perturbation treatment. The best f to experimental values is obtained using Hartre wave functions. Slater functions account for th general trends and breaks in the curves of distanc and force constant *vs.* atomic number, and for th anomalous values noted by the Sheline in the transitio elements. A

539.133 : 539.154.

8156. Periodicity of some molecular properties diatomic hydrides. R. K. SHELINE. *J. Chem. Phys* **18**, 927–32 (*July*, 1950).

The log of the force constants of the ground elec tronic states of all available diatomic hydrides plotted *vs.* the log of the atomic number of th element to which the H's are bonded. A definit periodicity associated with the periods in the periodi table results. This periodicity is used to predict th force constants of 10 diatomic hydrides which hav as yet not been investigated. A plot of hydrid interatomic distance *vs.* the atomic number of th "united atom" shows a similar periodicity and stron shell structure and allows the prediction of 13 nev interatomic distances for hydrides. These data an interpreted as evidence for the "united atom" mod for hydrides. Finally plots of the low lying atomi

energy states for atoms suggest that the seemingly inconsistent *d* shell periodicity may be the result of the mixing of energy states and hence a different type of hybridization trend in the *d* shell. A.

ATOMIC STRUCTURE . ISOTOPES 539.15

539.152.1

8157. The doublets of N^{15} and O^{16}. D. R. INGLIS. Letter in *Phys. Rev.*, **78**, 616–17 (*June* 1, 1950).

539.152.1

8158. Equivalence of protons and neutrons in nuclei. W. D. HARKINS. Letter in *Phys. Rev.*, 78, 634 (*June* 1, 1950).

This is inferred from consideration of some features of absolute abundance measurements of nuclear species. J. HUGHES

539.152.1

8159. An estimate for the position of the lowest dipole-level of a nucleus. B. F. TOUSCHEK. Letter in *Phil. Mag.*, **41**, 849–51 (*Aug.*, 1950).

539.152.1 : 539.164.2

Nuclear radii from alpha-decay theory. *See Abstr.* 8191

539.152.1 : 539.172.4

8160. Capture cross-sections for slow neutrons and nuclear structure. G.-J. BÉNÉ, P.-M. DENIS AND R.-C. EXTERMANN. *Arch. Sci.*, 3 (*No.* 2) 162–5 (1950) *In French.*

The capture cross-sections of a series of nuclei for slow neutrons are plotted against atomic number for nuclei of odd and even atomic number respectively; and it is found that nuclei with 8, 20, 50 or 82 protons, or 8, 20, 50, 82 or 126 neutrons, have smaller cross-sections than their neighbours. Secondary minima are also noticed, suggesting new "magic numbers" corresponding to 40, 70 and 112 neutrons, and 40 and 70 protons, which would be expected according to the nuclear model of M. G. Mayer. The "magic number" 28, also to be expected on this model is, however, not observed. J. THEWLIS

539.152.1 : 539.172.4

8161. Fast neutron cross sections and nuclear shells. D. J. HUGHES AND D. SHERMAN. Letter in *Phys. Rev.*, **78**, 632–3 (*June* 1, 1950).

The fast neutron activation cross-sections have been measured for unmoderated fission neutrons. Nuclei with 50, 82 and 126 neutrons have extremely small capture cross-sections suggesting low level densities in the compound nuclei formed. To obtain the necessary decrease in level spacing in the statistical nuclear model, a much larger discontinuity in binding energy than is known to exist is needed. J. HUGHES

539.152.1 : 539.185.7

8162. Search for nuclear energy levels in C^{13}. D. W. MILLER. Letter in *Phys. Rev.*, **78**, 806 (*June* 15, 1950).

539.152.2

8163. Use of a high frequency oscillator in the study of nuclear [paramagnetic] resonance. R. GABILLARD AND M. SOUTIF. *C.R. Acad. Sci., Paris*, **230**, 1754–6 (*May* 15, 1950) *In French.*

The oscillator consists of 2 coupled circuits; relations are given for the frequency and amplitude of the oscillations in terms of circuit and valve characteristics. Nuclear resonance may be studied by placing the specimen in the coil included in the grid circuit, thus changing the apparent inductance and resistance of that coil [Abstr. 2623 (1950)]. The frequency and amplitude of the oscillations are thus changed by amounts depending on the nuclear susceptibilities. The amplitude changes are measured as functions of the field for a ferric nitrate solution.

E. P. WOHLFARTH

539.152.2

8164. Nuclear magnetic moment of Sc^{45}. D. M. HUNTEN. Letter in *Phys. Rev.*, **78**, 806 (*June* 15, 1950).

539.152.2

8165. On the possibility of electric dipole moments for elementary particles and nuclei. E. M. PURCELL AND N. F. RAMSEY. Letter in *Phys. Rev.*, **78**, 807 (*June* 15, 1950).

539.152.2

8166. An experimental investigation of the nuclear magnetic moments of D^2 and H^1. G. LINDSTRÖM. *Phys. Rev.*, **78**, 817–18 (*June* 15, 1950).

539.152.2

8167. On the magnetic moments of Tl^{203}, Tl^{205}, Sn^{115}, Sn^{117}, Sn^{119}, Cd^{111}, Cd^{113}, and Pb^{207}. W. G. PROCTOR. *Phys. Rev.*, **79**, 35–44 (*July* 1, 1950).

A radiofrequency spectrometer for observing nuclear induction signals is described. The use of crossed radiofrequency coils allows, in a simple fashion, the determination of the signs of the magnetic moments. The magnetic moment values given are based on a proton moment, without diamagnetic correction, of $(2{\cdot}7935 \pm 0{\cdot}0003)$ nuclear magnetons. A.

539.152.2

8168. Nuclear magnetic resonance of Sb^{121} and Sb^{123}. V. W. COHEN, W. D. KNIGHT, T. WENTINK, JR. AND W. S. KOSKI. Letter in *Phys. Rev.*, **79**, 191 (*July* 1, 1950).

539.152.2 : 535.338.332

Nuclear spin of yttrium, tungsten and tellurium. *See Abstr.* 7866–7

539.152.2 : 538.222

Nuclear resonance and magnetic field changes of 1 in 10^6. *See Abstr.* 8123

539.153

8169. On the magnetic shielding in He and H_2. E. HYLLERAAS AND S. SKAVLEM. *Phys. Rev.*, **79**, 117–22 (*July* 1, 1950).

The magnetic shielding constant for the He atom (i.e. the value of $(-\Delta H/H)$ at the nucleus), has been calculated to a high degree of accuracy by comparison of values obtained from a number of known first and higher approximations to the wave function. Its value is $5{\cdot}9938 \times 10^{-5}$. Next, the shielding constant for the H_2 molecule with respect to either of the nuclei has been found in the first approximation to be $2{\cdot}6614 \times 10^{-5}$. The corresponding value derived from the Lamb formula is $3{\cdot}1648 \times 10^{-5}$. The difference is due to the combined effect of both the centre of mass and the centre of the electronic charge lying

outside either of the two nuclei. The numerical value $0{\cdot}5034\times10^{-5}$ of the difference fits well with the value $0{\cdot}53\times10^{-5}$ reported by Ramsay as derived from measurements of the spin-rotational interaction constants of the H_2 molecule. However, there is also a 2nd-order perturbation effect due to the perturbation of the ground state of the molecule by the magnetic field. By a special method its upper limit has been estimated to be $0{\cdot}2864\times10^{-5}$ and with a sign such as to weaken the magnetic field. Hence, the upper limit of the total shielding constant of H_2 should be $2{\cdot}9478\times10^{-5}$. A.

539.153

8170. Term values of f^4 electron configuration. K. Suryanarayana Rao. *Indian J. Phys.*, **24**, 51–6 (*Feb.*, 1950).

Using Slater's wave-mechanical method term values have been calculated for the complex f^4 electron configuration in terms of the well-known F's and G's of Slater with the help of Condon's tables for a^k's and b^k's. A table of these values for the different terms of this configuration is given. A.

539.153.4

8171. Some suggestions concerning the production and detection by optical means of inequalities in the populations of levels of spatial quantization in atoms. Application to the Stern and Gerlach and magnetic resonance experiments. A. Kastler. *J. Phys. Radium*, **11**, 255–65 (*June*, 1950) *In French.*

When a suitably directed and polarized beam of light falls on the atoms of a gas or on a molecular beam it is possible to produce an inequality in the populations of the various sub-states characterized by the magnetic quantum number m. An estimate shows that in practice the population ratio between two such states may be of the order of magnitude of 4 : 1. The detection of such inequalities would also be possible by an analysis of the intensity and polarization of optical resonance radiation. Such an optical study of the components of a Stern–Gerlach experiment would allow the extension of this experiment to metastable states. In the case of magnetic resonance experiments [e.g. Rabi, Millman and Kusch, *Phys. Rev.*, **55**, 526 (1939)] it is claimed that very important advantages would be gained (cheaper and more easily reproducible apparatus, wider range of applicability, etc.) by using the optical method in place of the conventional strong magnetic field to discriminate between the sub-states m in the incoming molecular beam (by creating inequalities in the populations of these states) and then analysing the beam similarly after its passage through the resonator where induced transitions between the states will have reduced the inequalities. The application of the method to nuclear resonance experiments is also described where a great increase in sensitivity is predicted. Temperature effects associated with such irradiations are discussed. W. J. Świątecki

539.153.4 : 530.145.6

One-parameter approximate wave-function for the fundamental state of atoms with two electrons. *See Abstr.* 7750

539.154

8172. On a natural system of screening constants and effective quantum numbers. K. W. F. Kohlrausch. *Acta Phys. Austriaca*, **3** (*No.* 4) 452–7 (1950) *In German.*

The two quantities, an effective nuclear charge and an effective principal quantum number for the outer most electron, can be used to deduce by simple calculation several important properties of atoms and ions, including X-ray energies, atomic radii, diamagnetic susceptibilities and polarizabilities. A complete list of constants is given. G. J. Kynch

539.15

8173. Masses of Si^{30}, Co^{59}, Ni^{60}, Zr^{90}, Mo^{9} and Mo^{100}. H. E. Duckworth, R. S. Preston and K. S. Woodcock. Letter in *Phys. Rev.*, **79**, 188–(*July* 1, 1950).

539.155.

8174. Some recent work on the separation and us of stable isotopes. I. Lauder. *J. Proc. Roy. Soc N.S.W.*, **82** (*No.* 3) 183–95 (1948).

A discussion of the known methods, except th electromagnetic one, of separating stable isotopes an examples of the uses of the stable isotopes of H, C N and C as tracers for the study of chemical reaction W. H. Dento

539.155.

8175. Ratio of carbon isotopes in meteorite A. V. Trofimov. *Dokl. Akad. Nauk, SSSR*, 7 (*No.* 4) 663–6 (1950) *In Russian.*

Gives the result of the comparative study of th isotopic composition of C in 26 aerolites, 10 siderite and 3 siderolites. The mean ratio $C^{12}:C^{13}$ fo aerolites is 90·61, that for siderites 90·68; all value obtained for 39 meteorites vary between 89·6 an 91·8. The ratio for telluric limestone is $89{\cdot}2\pm0{\cdot}2$ for mineral oil 91·7, for cotton wool 90·6, for bee sugar 90·9, for $BaCO_3$ (reagent) 90·9. Thus th meteoric C occupies a place between oil C an carbonate C; the meteoric C is more homogeneou than C in the biosphere of the earth. The $C^{12}:C$ ratio of the primary telluric carbon is calculated t be 90·3. This result and that of the research o 10 other elements [Abstr. 3333 (1950)] enable th author to state that the earth and these 35 meteorite have a common nuclear origin. F. Lachma

539.155.

8176. Separation of the neon isotope Ne^{20}, 99·95% isotopic purity, in a thermal diffusion column K. Clusius and M. Huber. *Experientia*, **6** (*No.* 262–3 (1950) *In German.*

539.155.2 : 523.87

The C^{12} to C^{13} abundance ratio in stellar atmospheres. *See Abstr.* 7721

RADIOACTIVITY . α-, β- AND γ-RAYS 539.1

539.16.0

8177. An analysis of multiple counter technique fo the measurement of radioactive sources independent geometry. S. Hertz, G. E. Whitham, A. MacLeod L. Hanopol and A. Miller. *Science*, **111**, 576- (*May* 26, 1950).

The resultant efficiency of an arrangement of

G.M. counters disposed symmetrically on the circumference of a circle, radius R, is investigated as a function of the position of a point source in the interior of the circle, under certain simplifying assumptions; the variation is $< 5\%$ within a distance of $R/5$ from the centre. A. O. STANESBY

539.16.08

8178. Irradiation of small volumes by contained radioisotopes. P. I. RICHARDS AND B. A. RUBIN. *Nucleonics*, **6**, 42–9 (*June*, 1950).

A study of the energy loss from internally irradiated volumes when the average path of the emitted particle is comparable to the linear dimensions of this volume. The fraction of the ionization lost to volumes containing uniform source concentration is evaluated for the cases of uniform ionization along the track (fast β-particle K.E. $> 2mc^2$) and non-uniform ionization (slow β-particle) for various geometric shapes with dimensions $>$ and $<$ the particle ranges. L. R. SHEPHERD

539.16.08

8179. Time and count control in radiometric counting measurements. D. TAYLOR. Note in *J. Sci. Instrum.*, **27**, 206 (*July*, 1950).

539.16.08

8180. A transportable radiation monitor. K. KANDIAH AND M. O. DEIGHTON. *J. Sci. Instrum.*, **27**, 219–22 (*Aug.*, 1950).

Although primarily designed as a radiation health monitor, it is capable of measuring the counting rate due to alpha-, beta- or gamma-activity with an accuracy of about 1%, and should therefore be useful for certain types of experimental or routine investigations. It is a mains-operated electronic instrument giving direct readings of counting rate up to 2 000 counts/sec, and loudspeaker indication is also provided. Certain parts of the circuit are described in detail, since they seem capable of wider application than here described. A.

539.161 : 778.33 : 551.8

8181. Distribution of radioactivity in granite. E. PICCIOTTO. *C.R. Acad. Sci., Paris*, **230**, 2282–4 (*June* 26, 1950) *In French.*

Autoradiographic methods have been applied to studying the distribution of radioactivity in granite. Figures for distribution between inclusions, dispersion and concentration in fissures are given. The importance of the results as regards the He method of measuring geological age is noted. G. O. BAINES

539.163.1

8182. The chromium isotope of mass 55. D. R. MILLER. Letter in *Phys, Rev.*, **78**, 808 (*June* 15, 1950).

No evidence was found for the production of Cr^{55} with $\frac{1}{2}$-life between 15 min or 100 days by n-bombardment of Mn.

539.163.1

8183. Erratum: Measurement of a $1{\cdot}6\times10^{-9}$ second half-life in Yb^{170}. R. E. BELL AND R. L. GRAHAM. *Phys. Rev.*, **79**, 69, 194 (*July* 1, 1950).

539.163.2

8184. Copper 61 and 67. D. N. KUNDU AND M. L. POOL. Letter in *Phys. Rev.*, **78**, 488–9 (*May* 15, 1950).

By bombardment by α-particles of Ni enriched in Ni^{64}, and by neutrons of Zn enriched in Zn^{67}, Cu activities previously known [Abstr. 2054 (1949)] of 3·4 hr and about 60 hr $\frac{1}{2}$-life are assigned to Cu^{61} and Cu^{64} respectively. The second $\frac{1}{2}$-life is measured to be $2{\cdot}44 \pm 0{\cdot}02$ d and is associated with a beta-activity of end-point $0{\cdot}54 \pm 0{\cdot}04$ MeV together with one gamma-ray per beta-particle. A long period obtained in the Ni + α reaction is tentatively associated with a $1{\cdot}2 \pm 0{\cdot}1$ MeV beta-ray end-point. B. ROSE

539.163.2

8185. The disintegration of Cu^{61}. G. E. OWEN, C. S. COOK AND P. H. OWEN. *Phys. Rev.*, **78**, 686–90 (*June* 15, 1950).

By the use of very thin and uniform sources prepared by thermal evaporation, the positron spectrum of Cu^{61} continues to show an excess of particles in the low energy region. The presence of nuclear gamma-rays and internal conversion electrons indicates that the disintegration of Cu^{61} is complex. Magnetic spectrometer studies of the radiations from Cu^{61} have led to a tentative disintegration scheme. A.

539.163.2

8186. Radioactive ^{165}Er. F. D. S. BUTEMENT. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 775 (*July*, 1950).

The Er was prepared by Ho^{165} (p, n) Er^{165}; no electron or positrons were found, the only radiation (10 hr $\frac{1}{2}$-life) being 6·6 and 47–52 keV gamma-rays, these being presumed to be Ho K and L X-rays. The Er therefore decays entirely by orbital electron capture.

539.163.2 : 539.172.1

8187. Isotopic assignments of bismuth isotopes produced with high energy particles. H. M. NEUMANN AND I. PERLMAN. *Phys. Rev.*, **78**, 191–8 (*May* 1, 1950).

A number of isotopes of Bi (198–201, 203) have been identified from the bombardment of Pb with high energy deuterons and protons. Evidence for these assignments is based chiefly on the daughter Pb and Tl activities resulting from electron-capture decay. Those isotopes exhibiting alpha-decay have been investigated as to energy and half-life for this mode of decay. A discussion is given of the relationship between half-life and energy for all known alpha-active Bi isotopes. A.

539.163.2 : 539.172.11

8188. Neutron deficient isotopes of iodine. L. MARQUEZ AND I. PERLMAN. *Phys. Rev.*, **78**, 189–90 (*May* 1, 1950).

The iodine isotopes I^{123}, I^{122}, I^{121} and I^{120}(?) have been made by bombarding Sb with α-particles. Their characteristics are summarized and evidence for mass assignments presented. A.

539.164 : 539.166

8189. α–γ angular correlation. J. THIRION. *C.R. Acad. Sci., Paris*, **230**, 2090–2 (*June* 12, 1950) *In French.*

An expression is obtained in the general case for the probability of emission of a γ-ray at an angle θ from a previously emitted α-particle. A. O. STANESBY

539.164 : 778.34

8190. On the determination of the ranges of low energy α-particles in nuclear emulsions. P. Cüer, J.-P. Lonchamp, J. Combes and S. Gorodetzky. *C.R. Acad. Sci., Paris*, **230**, 1764–6 (*May* 15, 1950) *In French.*

By using fine grain D_1 emulsion, and measuring intervals, 0·0461 μ, $< \frac{1}{4}$ of the standard deviation of the measured range, the range of the α-particles from $Li^6(n, \alpha)H^3$ was found to be $6{\cdot}19 \pm 0{\cdot}04$ μ. The measured spread of the ranges was greater than that obtained in a cloud chamber (1·75 μ ≡ 2·8 mm air cfd with 2 mm) [Abstr. 2730 (1949)], but the accuracy greater (0·7% cfd with 2%) owing to the absorber correction in the latter. It is concluded that the stopping power of the emulsion for velocities $\sim 10^9$ cm/sec is $> 1\,600$, distinctly $>$ than the theoretical value of Bethe [Livingston and Bethe, *Rev. Mod. Phys.*, **9**, 272 (1937)]. B. Rose

539.164.08 : 537.542

The use of diamonds as radiation detectors. *See Abstr.* 8069

539.164.2 : 539.152.1

8191. Consistency of nuclear radii of even-even nuclei from alpha-decay theory. I. Perlman and T. J. Ypsilantis. *Phys. Rev.*, **79**, 30–4 (*July* 1, 1950).

It is possible to obtain a consistent function for nuclear radii if the quantitative treatment of the alpha-decay process is applied to even-even isotopes of the heavy elements. The nuclear radii so calculated for even-even isotopes of Em, Ra, Th, U, Pu and Cm, conform to the expression $r = 1{\cdot}48 \times 10^{-13} \cdot A^{\frac{1}{3}}$ cm which defines the normal nuclear radii. The agreement is within 1% for the majority of the cases and there is reason to question the experimental data used in the calculations for at least part of those which do not show such close agreement. In cases of fine structure in alpha-decay of even-even nuclei, the radii calculated from the separate alpha-groups are compatible. The Po isotopes and Em^{212} form a special group showing departures from normal nuclear radii explainable by consideration of shells in nuclear structure. A.

539.165

8192. Beta ray spectrum of K^{40}. D. E. Alburger. Letter in *Phys. Rev.*, **78**, 629–30 (*June* 1, 1950).

Using K (in KCl) enriched to 7·13% of K^{40}, the β-spectrum was found to give a linear Kurie plot down to 550 keV when corrected by the Marshak factors c or D_2 corresponding to 3rd or 2nd forbidden transitions respectively. The uncorrected plot, and those corrected by the 1st or 4th forbidden factors were markedly non-linear. The source had a mean thickness of 2·4 mg/cm², and allowance for this was made by comparison with the spectrum of a source of P^{32} mixed with KCl of the same mean thickness. The K^{40} end-point was $1{\cdot}36 \pm 0{\cdot}03$ MeV, taking the P^{32} end-point as 1·715 MeV. B. Rose

539.165

8193. Beta-spectrum of Ne^{23}. H. Brown and V. Perez-Mendez. Letter in *Phys. Rev.*, **78**, 812 (*June* 15, 1950).

539.165

8194. Double beta-decay of Te^{130}. M. G. Inghram and J. H. Reynolds. Letter in *Phys. Rev.*, **78**, 822–3 (*June* 15, 1950).

Continuation [see Abstr. 1964 (1950)].

539.165

8195. The disintegration of As^{72}. J. Y. Mei, A. C. G. Mitchell and C. M. Huddleston. *Phys. Rev.*, **79**, 19–22 (*July* 1, 1950).

The spectra of the various radioactive arsenics produced by high energy alpha-particle bombardment of Ga have been studied using a magnetic lens spectrograph. These isotopes consist of As^{72} (26 h), As^{74} (19·5 d), As^{73} (90 d) and As^{71} (60 h). The main investigation concerns As^{72}. This element is found to emit 5 positron groups of end-point energies 3·339 (19·3%), 2·498 (64·6%), 1·844 (12·1%), 0·665 (5·0%) and 0·271 (2·0%) MeV. A strong gamma-ray of energy 0·835 MeV together with many weak gamma-rays with energies up to 3 MeV have been found. The levels of the product nucleus Ge^{72} agree well with those found from a study of Ga^{72}. The highest energy positron group has a forbidden shape. The spectrum of As^{74} consists of one gamma-ray of energy 0·593 MeV, 2 negatron groups of energies 1·45 and 0·82 MeV together with a positron group of energy about 0·96 MeV. As^{73} disintegrates by K-electron capture and the emission of an internal conversion line corresponding to a gamma-ray of 0·052 MeV. An internal conversion line corresponding to a gamma-ray at 0·162 MeV is ascribed to As^{71}. A.

539.165

8196. Radiations of Zr^{97} and Nb^{97}. W. H. Burgus, J. D. Knight and R. J. Prestwood. *Phys. Rev.*, **79**, 104–7 (*July* 1, 1950).

The radiations of Zr^{97} and Nb^{97} have been examined by beta-ray spectrometry and coincidence counting. The 17·0 hr Zr^{97} has been found to decay to a 60 sec isomer of Nb^{97}, the latter undergoing isomeric transition to the 75 min Nb^{97} ground state. The disintegration energies are: Zr^{97}, $E_\beta = 1{\cdot}91 \pm 0{\cdot}02$ MeV; $Nb^{97}{}_m$, $E_\gamma = 0{\cdot}747 \pm 0{\cdot}005$ MeV; Nb^{97}, $E_\beta = 1{\cdot}267 \pm 0{\cdot}02$ MeV; $E_\gamma = 0{\cdot}665 \pm 0{\cdot}005$ MeV. A.

539.165 : 539.166

8197. Beta-gamma-angular correlation. S. L. Ridgway. Letter in *Phys. Rev.*, **78**, 821 (*June* 15, 1950).

539.165 : 539.166

8198. Beta-gamma and gamma-gamma angular correlation experiments on Sb^{124}. J. R. Beyster and M. L. Wiedenbeck. Letter in *Phys. Rev.*, **79**, 169–70 (*July* 1, 1950).

539.165 : 539.152.1

8199. Remarks on the quasi-atomic model and nuclear β-transitions. R. Bouchez. *C.R. Acad. Sci. Paris*, **231**, 139–41 (*July* 10, 1950) *In French.*

Some results are given of a theoretical study of the classification of beta-transitions (into allowed and forbidden) based on a quasi-atomic model in which a stationary state of a nucleus can be represented as a superposition of a small number of configurations characterized by (J, L), (J, L'), . . . where L, L', . . . have the same parity. A satisfactory interpretation of beta-transitions is obtained. W. J. Swiatecki

539.165 : 539.152.2

8200. The polarization of β-rays emitted by oriented nuclei. H. A. TOLHOEK AND S. R. DE GROOT. *C.R. Acad. Sci., Paris*, **230**, 1580–2 (*May* 3, 1950) *In French.*

The significance of the orientation of nuclear spin at very low temperatures is discussed in the case of β-emitters. It is shown that the β-rays would be polarized. It is suggested that this process could be used for measuring the magnetic moments of radioactive nuclei. G. O. BAINES

539.165.08 + 539.166.08

8201. Gamma and beta ray spectroscopy with proportional counters in magnetic fields. S. C. CURRAN, A. L. COCKROFT AND G. M. INSCH. *Proc. Phys. Soc., Lond. A*, **63**, 845–7 (*Aug.*, 1950).

Proportional counters operating in a "condensing" type of magnetic field can be used as β- or γ-ray spectrometers up to at least 2 MeV. Results for P^{32} and annihilation γ-radiation are given. A.

539.166

8202. Conversions in the subgroups of the *L*-shell. V. S. SHPINEL AND N. V. FORAFONTOV. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 1) 49–52 (1950) *In Russian.*

The ratios between the conversion coefficients in the subgroup of the *L* shell for the γ-transition 238 keV in ThC were measured, using a special β-spectrometer with a non-homogeneous transverse magnetic field with axial symmetry, and possessing a large resolving capacity. The electrons were registered by 2 β-counters, working in coincidence and placed in a common box filled with a mixture of argon and ethylene. The source was a thin film of ThC on a Pt wire of dia. 0·05 mm. The conversion lines for the *L*, *M* and *N* groups for the γ-transition are given graphically and the ratios of the conversion coefficients in tabular form, the latter being compared with results obtained previously by Flammersfeld [*Z. Phys.*, **114**, 227 (1939)] W. HUGHES

539.166

8203. The internal conversion electrons of several short-lived neutron induced radioactivities. R. L. CALDWELL. *Phys. Rev.*, **78**, 407–11 (*May* 15, 1950).

Accurate values of the transition energy were measured for 7 neutron-induced radioactivities using a permanent magnet β-ray spectrograph. A special vacuum gate permitted the introduction of short-lived samples within 12 sec after the end of bombardment without disturbing the vacuum in the spectrograph. Transition energies, accurate to about 1%, were determined as follows: Cs (3 hr) 128·0 keV, Co (10·7 min) 58·9 keV, Cb (6·6 min) 41·5 keV, Dy (1·3 min) 109·0 keV, Dy (2·6 hr) 87·8 keV, Ir (1·5 min) 57·4 keV, Tm (120 day) 84·8 keV. For the 5 isomeric transitions, approximate values of the relative intensities of the electron lines were determined, and an assignment was made of the multipole order of the radiation, assuming electric multipole radiation. A.

539.166

8204. Nuclear recoil momentum in pair production. B. ROSENBAUM. Letter in *Phys. Rev.*, **78**, 628 (*June* 1, 1950).

Experimental observations [Abstr. 4117 (1950)] do not agree at low values of nuclear momentum with an exact numerical calculation of Bethe's function [*Proc. Camb. Phil. Soc.*, **30**, 524 (1934)].

539.166.

8205. Gamma-radiation from Ne^{23}. V. PEREZ-MENDEZ AND H. BROWN. Letter in *Phys. Rev.*, **78**, 812–13 (*June* 15, 1950).

539.166

8206. Correlation in the direction and polarization of two successive quanta for Rh^{106}, Co^{60}, and Cs^{134}. A. H. WILLIAMS AND M. L. WIEDENBECK. Letter in *Phys. Rev.*, **78**, 822 (*June* 15, 1950).

539.166

8207. The detection of positron-conjoint nuclear gamma-radiation. H. E. KUBITSCHEK. *Phys. Rev.*, **79**, 23–7 (*July* 1, 1950).

An absorption technique is described for the rapid detection and measurement of nuclear gamma-radiation from positron emitters. Applicability of the method was shown in the verification of the energy and intensity of the gamma-ray from Cu^{64}. The method was further used to find a new gamma-ray of $0·81 \pm 0·01$ MeV from Ti^{45}; the number of positrons per gamma is $(19 \pm 2) : 1$. The positron maximum energy of $1·00 \pm 0·02$ MeV was also observed and *K*-electron capture demonstrated. A.

539.166.08

8208. Comparison method of measuring the angular correlation of gamma-rays. J. GIERULA. *Acta Phys. Polon.*, **10** (*No.* 1–2) 87–8 (1950).

The use of 3 counters, 2 fixed at right angles with respect to source and one movable, is recommended for improving the accuracy of angular correlation studies. It is claimed that the results obtained by this method are not sensitive to variation in working conditions during the course of the experiments.

L. R. SHEPHERD

539.166.74

8209. On the diffusion and propagation of γ-rays in a homogeneous medium. P. MAIGNAN. *C.R. Acad. Sci., Paris*, **230**, 2018–20 (*June* 5, 1950) *In French.*

A monokinetic γ-ray source at the centre of a spherical medium is considered. An expression is given for the flux of photons which emerge from the sphere after being scattered *n* times and the approximate calculation of some of the parameters involved is outlined for the case of water spheres (when only Compton scattering is involved). The mean cosines of the angles (to the radial direction) of photons which emerge from the sphere after one and more than one collision are tabulated for primary energies of 0·5, 1 and 2·6 MeV and for sphere radii of 20 to 1 000 cm. These cosine values can then be used in a simple expression to give the mean photon energies.

L. R. SHEPHERD

539.169

8210. The separation of the isomers of In^{114} and In^{112} in an electric field. G. J. GOLDSMITH AND E. BLEULER. *J. Phys. Coll. Chem.*, **54**, 717–23 (*May*, 1950).

It is shown that the separation of nuclear isomers of a metal is possible by subjecting an organic compound of the metal in a nonconducting solution to a high electric field. In the case of the In^{112} isomers,

the assignment of half-lives to the two levels is confirmed unambiguously. The mechanism of the separation is not clearly understood; it is felt that further investigation of simple cases, like the Br^{80} separation, is highly desirable. A.

NUCLEAR REACTIONS 539.17

539.172

8211. Measurement of the disintegration energy of Be^8 based on associated branches of cosmic ray stars. J. CRUSSARD. *C.R. Acad. Sci., Paris,* **231,** 141–3 (*July* 10, 1950) *In French.*

Be^8 emitted in the ground state in a cosmic-ray star has sufficient lifetime to pass beyond the influence of the parent nucleus before decaying to 2 alpha-particles. The latter appear characteristically as closely associated tracks. In 3 000 stars obtained at altitude 20–30 km, 16 examples of alpha pairs corresponding to energy of disintegration 100 keV were observed, and only 2 yielding significantly different values. Be^8 is thus usually emitted in the ground state. J. G. WILSON

539.172 : 539.152.1

8212. The range and the mean free path of high energy nucleons in nuclear matter. Y. FUJIMOTO AND Y. YAMAGUCHI. Letter in *Progr. Theor. Phys.,* **5,** 141–2 (*Jan.–Feb.,* 1950).

539.172.13

8213. Properties of the $T^3(p, \gamma)He^4$ reaction. H. V. ARGO, H. T. GITTINGS, A. HEMMENDINGER, G. A. JARVIS AND R. F. TASCHEK. *Phys. Rev.,* **78,** 691–4 (*June* 15, 1950).

Yield and angular distribution measurements on the $T^3(p, \gamma)He^4$ reaction have been made for protons up to 2·5 MeV. The yield indicates a resonance in the He^4 nucleus at a proton energy of about 2·5 MeV, giving an excited level at 21·6 MeV. The angular yield of the gamma-rays fits an $A + B \sin^2\theta$ distribution very well, suggesting that the gamma-rays are due predominantly to a transition from the $^1P_1$ state to the $^1S_0$ state. An Al absorption curve for the secondaries produced in a Pb radiator was taken, and a direct comparison made with the 17·5 MeV gamma-rays from the $Li^7(p, \gamma)Be^8$ reaction, showing that the $T^3(p, \gamma)He^4$ gamma-rays are of higher energy. A.

539.172.13

8214. Proton capture radiation of fluorine-19. E. R. RAE, J. G. RUTHERGLEN AND R. D. SMITH. Letter in *Proc. Phys. Soc., Lond. A,* **63,** 775–7 (*July,* 1950).

539.172.13

8215. Low energy alpha-particles from fluorine bombarded by protons. C. Y. CHAO, A. V. TOLLESTRUP, W. A. FOWLER AND C. C. LAURITSEN. *Phys. Rev.,* **79,** 108–16 (*July* 1, 1950).

The low energy alpha-groups from the reaction $F^{19}(p, \alpha)O^{16*}$ have been studied at various resonances between proton energies of 340 keV and 1 381 keV. Four groups have been identified. For the reaction energy of the α_π group, preceding the pair emission, we find $Q_\pi = 2{\cdot}061 \pm 0{\cdot}010$ MeV and for the 3 other groups preceding gamma-ray emission we find $Q_1 = 1{\cdot}977 \pm 0{\cdot}008$, $Q_2 = 1{\cdot}204 \pm 0{\cdot}008$ and $Q_3 = 1{\cdot}002 \pm 0{\cdot}008$ MeV. Each of the Q-values when added to the corresponding pair-energy or gamma-ray energy found by Rasmussen, Hornyak, Lauritsen, and Lauritsen gives a value for the total reaction energy of $F^{19}(p, \alpha)O^{16}$ which is the same for all the groups, namely 8·113 ± 0·030 MeV. The relative intensities of the α_1, α_2 and α_3 groups are found to vary from one resonance to another and the sum of their absolute yields per proton per 4π-steradians at 138° is found to be very close to the absolute yield of the gamma-rays per proton per 4π-steradians at 90° at all the resonances investigated, the gamma-ray yield being measured simultaneously with the alpha-particle yields. The absolute yield of the α_π-group agrees in order of magnitude with the pair yield determined in this laboratory and elsewhere. The small discrepancies can probably be attributed to angular distribution factors. The excitation functions of the α_1- and α_2-groups have been compared carefully with that of the gamma-rays over certain regions of the proton energy. Over each resonance, the excitation functions of the alpha-groups and the gamma-rays can be represented by the same curve by suitable normalizations. Our excitation curve of the α_π-group is found to run parallel with the excitation curve of the pairs found by Bennett *et al.* A.

539.172.13

8216. Angular correlation in the reaction $F^{19}(p, \alpha)O^{16}(\gamma)O^{16}$. W. R. ARNOLD. Letter in *Phys. Rev.,* **79,** 170 (*July* 1, 1950).

539.172.13

8217. Gamma-ray spectra from B^{10}, B^{11}, and Be^9 under proton bombardment. R. L. WALKER. Letter in *Phys. Rev.,* **79,** 172–3 (*July* 1, 1950).

539.172.13

8218. Neutron spectrum for protons on Be^9. V. R. JOHNSON, F. AJZENBERG AND M. J. W. LAUBENSTEIN. Letter in *Phys. Rev.,* **79,** 187–8 (*July* 1, 1950).

539.172.13

8219. Angular correlation between α-particles and γ-rays in the reaction $F^{19}(p, \alpha\gamma)O^{16}$. C. A. BARNES, A. P. FRENCH AND S. DEVONS. Letter in *Nature, Lond.,* **166,** 145 (*July* 22, 1950).

539.172.13

8220. Production of beryllium-7 by proton bombardment of carbon. J. M. DICKSON AND T. C. RANDLE. Letter in *Nature, Lond.,* **166,** 235 (*Aug.* 5, 1950).

539.172.13

8221. The angular distribution of protons from the reaction $^{27}Al(d, p)^{28}Al$. J. R. HOLT AND C. T. YOUNG. *Proc. Phys. Soc., Lond. A,* **63,** 833–8 (*Aug.,* 1950).

Experiments are described in which a differential ionization chamber was used in the measurement of angular distributions of disintegration particles. Results are given for 7 groups of protons from the (d, p) reaction with Al in which deuterons having energies of 4·6, 5·8 and 7·5 MeV were used. The distribution curves are of complicated form, with a general tendency for the protons to be emitted in the forward direction. A.

539.172.13

8222. Angular distributions of ground-state protons from $B^{10} + D$. W. C. REDMAN. *Phys. Rev.*, **79**, 6–11 (*July* 1, 1950).

This has been investigated at 6 energies in the 1 to 4 MeV interval. The reaction protons were recorded photographically at all angles from 5° to 165° and their distribution was determined by microscopic examination of the photographic emulsion. The resulting intensity variation with angle can be expressed within experimental error as a 2nd-order Legendre polynomial series for all energies except the highest, for which a 4th-order series is required. *S*-wave deuterons predominate in producing this reaction, but *p*-wave effects occur even for the lowest energy distribution studied. *D*-wave contributions are noticed for deuteron energies above 3 MeV. The behaviour of the coefficients in the series representation shows that several broad overlapping resonance levels, of both even and odd parity, in the compound nucleus probably enter into this reaction. A.

539.172.13

8223. Proton groups from the deuteron bombardment of aluminum, sodium, and manganese. W. D. WHITEHEAD AND N. P. HEYDENBURG. *Phys. Rev.*, **79**, 99–103 (*July* 1, 1950).

Thin targets of Na, Al, and Mn were bombarded with 3·0 MeV deuterons from the large electrostatic generator at the Department of Terrestrial Magnetism, and the protons were observed at 90 degrees to the beam with an A filled proportional counter. The counter was biased to count protons at the end of their range and the ranges of the groups were measured in air and Al. Proton groups due to O and C were found with all targets. A.

539.172.3

8224. Photo-disintegration of the deuteron at high energies. J. F. MARSHALL AND E. GUTH. *Phys. Rev.*, **78**, 738–44 (*June*, 1950).

Total cross-sections and angular distributions for the photo-disintegration of the deuteron for energies between 10 and 150 MeV are computed for various types of central neutron-proton interactions. Most of the explicit computations are carried out for the case of 50% ordinary and 50% exchange interaction. Neutron–proton interactions considered are of the square well, Yukawa and exponential type with 2 effective ranges. Theoretical analysis of the experimental data on high energy neutron–proton scattering excludes the square well, but is compatible with both Yukawa and exponential types of potentials. The Yukawa potential is replaced by an equivalent Hulthén potential. For the square-well and exponential potentials explicit analytic solutions were obtained. Our treatment of the case of the exponential potential is rigorous and at the same time almost as simple as that of the Hulthén potential. A qualitative discussion of the photo-electric dipole transition is given on the basis of the *f*-sum rule. This shows how exchange forces greatly increase the cross-section at high energies. The discussion can be carried out for any exchange ratio. It is pointed out that only the photo-electric dipole and quadrupole cross-sections can be obtained independently of specific meson theories of nuclear forces. The results for photo-disintegration show a pattern similar to those on neutron–proton scattering: very little difference between Yukawa and exponential potentials, somewhat larger difference between these two and the square-well potential. There is a pronounced dependence on effective range. A simple derivation of the dipole cross-section for the ordinary square well potential is given, based on a transformation involving the equations of motion. A.

539.172.3

8225. The ejection of Li^8 nuclei by gamma-rays. C. H. MILLAR AND A. G. W. CAMERON. Letter in *Phys. Rev.*, **79**, 182–3 (*July* 1, 1950).

539.172.3

8226. Photodisintegration of the heavy elements. R. W. PARSONS AND C. H. COLLIE. *Proc. Phys. Soc., Lond. A*, **63**, 839–44 (*Aug.*, 1950).

The photo thresholds for the emission of neutrons by the following elements have been determined. The threshold in MV is given in the brackets following the symbol: Pt $(6{\cdot}1 \pm 0{\cdot}1)$; Au $(8{\cdot}1 \pm 0{\cdot}1)$; Hg $(6{\cdot}6 \pm 0{\cdot}2)$; Tl $(7{\cdot}3 \pm 0{\cdot}25)$; Pb $(6{\cdot}9 \pm 0{\cdot}1)$; Bi $(7{\cdot}2 \pm 0{\cdot}1)$; Th $(6{\cdot}0 \pm 0{\cdot}15)$; U $(5{\cdot}8 \pm 0{\cdot}15)$. The neutrons were detected by the Szilard and Chalmers method of chemical concentration and the γ-rays obtained from a small betatron. Rough values of the total cross-sections can be estimated from the results. A.

539.172.4

8227. On the energy loss by fission fragments along their range. N. O. LASSEN. *K. Danske Vidensk. Selsk. Mat.-fys. Medd.*, **25** (*No.* 11) 42 *pp.* (1950).

Specific ionization at various distances along the tracks of slow neutron-induced U fission fragments has been measured in A, X, H_2, D_2 and He. The U, deposited in a thin layer (0·33 mg/cm²) on a mica sheet, was covered by a diaphragm containing long narrow channels to restrict observations to fragments emerging nearly perpendicular to the sheet. The specific ionization was determined from the heights of pulses produced between two flat electrodes, mounted parallel to the U layer at an adjustable distance from the latter in the test gas at a suitable pressure. Specific ionization distributions were obtained at various track distances, in general two peaks being observed, corresponding to the light and heavy fragments; specific ionization *v.* range curves are deduced. The two curves cross (at least in the case of A) near the beginning of the track, the heavy particle producing the highest initial ionization. The ranges obtained by extrapolation of these ionizations are appreciably < the total reduced ranges observed by other authors. This arises from the fact that energy loss at the end of the track occurs through nuclear collisions which produce negligible ionization. Curves are drawn for the specific energy loss over the complete tracks by combining the experimental ionization curves with curves for the end regions calculated from the Bohr theory, the energy scale being normalized to give total energies of 86 and 55 MeV for the light and heavy fragments respectively. Other curves are plotted giving total energy, velocity and effective charge of the fragments as a function of distance along the tracks, the effective charges being

deduced from the specific ionization, using a formula of Bohr. L. R. SHEPHERD

539.172.4

8228. Fast neutron bombardment effects in germanium. J. H. CRAWFORD, JR. AND K. LARK-HOROVITZ. Letter in *Phys. Rev.*, **78**, 815–16 (*June* 15, 1950).

539.172.4

8229. Delayed neutrons from U^{238} and Th^{232} fission. K. H. SUN, R. A. CHARPIE, F. A. PECJAK, B. JENNINGS, J. F. NECHAJ AND A. J. ALLEN. *Phys. Rev.*, **79**, 3–5 (*July* 1, 1950).

The half-lives of the delayed neutron emitters from U^{238} and Th^{232} fission were found to be 0·4, 1·7, 5·8, 22·6 and 55·2, and 0·41, 1·4, 4·4, 20 and 56 sec respectively, by using fast neutrons from 15 MeV cyclotron deuterons on a thick C target. These, when compared with those from the slow neutron fission of Pu^{239} and U^{235}, indicate that delayed neutron emitters from fission of Pu^{239}, U^{235}, U^{238} and Th^{232} are identical. The delayed neutron yield after saturation bombardment was about 8 per 100 fissions. A preliminary survey indicated that the 22 and 56 sec half-lives were also present when LiF or B_4C instead of C was used as the cyclotron target for producing faster neutrons. A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

8230. Varytrons. J. DAUDIN. *J. Phys. Radium*, **11**, 25D–29D (*June*, 1950) *In French.*

The work of Alichanyan in 1947 and 1948 is discussed. Observing various momenta for particles of given range, the existence in large numbers of particles with masses between 200 and 2 000 m_e was deduced, in conflict with other observations. The discrepancy is attributed to defects in the experimental method, and insufficient attention to statistical errors. E. P. GEORGE

539.18

8231. The nature of the neutral particle emitted in the decay of the π-meson. C. O'CEALLAIGH. *Phil. Mag.*, **41**, 838–48 (*Aug.*, 1950).

In order that momentum and energy be conserved in the process of π–μ-decay at rest, it is necessary to assume the emission of a single additional non-ionizing particle in a direction opposite to the initial line of motion of the μ-meson. There exists strong experimental evidence for the conclusion that the neutral particle has small or negligible rest-mass. Hence, we may suppose that it is either (*a*), some light neutral particle possibly identical with the neutrino of β-decay, or (*b*) a photon. Some 250 suitable cases of π–μ-decay in Ilford G5 Nuclear Research plates have been examined with a view to testing the hypothesis (*b*). A careful search has been made in the requisite direction, for associated pairs of electrons. In a total scan-length of 38 cm no such case was observed. Statistical analysis shows that, if indeed a photon were emitted, the probability that it would fail to produce a pair under the conditions of th experiment was 4×10^{-3}. Since this result woul appear to exclude the possibility of photon emissio it is inferred that the π-meson normally decays i accordance with (*a*). It is shown that the preser experiment has much in common with those devise to demonstrate the existence of the neutrino β-decay. A

539.18 : 530.14

8232. On the nature of τ-mesons. I. H. FUKUDA S. HAYAKAWA AND Y. MIYAMOTO. *Progr. Theo Phys.*, **5**, 283–304 (*March–April*, 1950).

The mass, the life and the interaction with nucleon of τ-mesons discovered in photographic plates ar qualitatively discussed. The probabilities of $\tau \rightarrow \pi -$ π^0 and $\tau \rightarrow \pi + \gamma$ for various combinations of thei couplings are calculated by Tomonaga–Schwinge formalism. The generalized selection rule for th system composed of many mesons is presented, fro which some particular sets of the types of thes mesons, for example scalar and pseudoscalar, ar admitted to explain the rather long life-time o τ-meson, $\sim 10^{-11}$ sec. The life time for $\tau \rightarrow 3\pi$ decay calculated by our method is obtained as lon as 10^{-11} sec. consistent with experiments. Thi result suggests that the interaction of π-meson wit nucleon is weak. Some arguments for and against such an assumption are discussed. The varieties o mesons, called varitrons, are classified as π- an μ-types. A

539.18 : 530.14

8233. On the μ-meson decay. S. OGAWA AN S. KAMEFUCHI. Letter in *Progr. Theor. Phys.*, 5 311–12 (*March–April*, 1950).

539.18 : 537.533.7

8234. Concerning meson produced secondary elec trons emerging from thin foils. F. L. HEREFORD *J. Franklin Inst.*, **249**, 449–54 (*June*, 1950).

The probability is computed that a meson traversin a thin foil will produce at least one secondary electro of sufficient energy to emerge from the foil with th meson. Numerical results are presented for variou meson momenta and foil thicknesses, and the bearin of these results upon certain low pressure G.M. counter experiments is discussed. A

539.18 : 539.16

8235. The gamma-ray spectrum from the absorptio of π^--mesons in hydrogen. W. K. H. PANOFSKY L. AAMODT AND H. F. YORK. Letter in *Phys. Rev.* **78**, 825–6 (*June* 15, 1950).

π^--mesons produced by 330 MeV protons on a W target in the Berkeley cyclotron, were allowed t fall on a pressure vessel containing H_2 at 2 700 lb/in and liquid N_2 temperature ($\rho = 0{\cdot}048$). Gamma rays were examined through 2 Pb collimators (t reduce background due to gamma-rays originatin outside the H_2) by means of a pair spectrometer an proportional counters. The total counting rate wa consistent with the emission of gamma radiation fo each π^--meson stopped in the H_2. The possibility o the radiation being due to p–p collisions of scattere protons was rejected. No gamma-rays were observe when hydrogeneous materials such as polyethylen

nd LiH replaced the H_2, the π^--mesons presumably eing captured in the heavier nuclei with no gamma-mission in these cases. The pair spectrum indi-ated 2 gamma components of 70 MeV and 130 MeV. t is suggested that a single gamma-radiation of 32 MeV accompanies a process $\pi^- + H \rightarrow n + \gamma$, vhile 2 70 MeV gamma-rays occur in an alternative rocess $\pi^- + H \rightarrow n + \pi^\circ + 2\gamma$ which also leads o a neutral π-meson. L. R. SHEPHERD

539.18 : 539.172.1

8236. The production of π^+-mesons by protons on protons in the direction of the beam. W. F. CARTWRIGHT, C. RICHMAN, M. N. WHITEHEAD AND H. A. WILCOX. Letter in *Phys. Rev.*, **78**, 823–4 (*June* 15, 1950).

539.185

8237. Pile neutron research techniques. III. D. J. HUGHES. *Nucleonics*, **6**, 50–55 (*June*, 1950).

The standardization of neutron sources is described nd methods of measuring source strengths, fluxes nd the "temperature" of thermal neutron distri-utions are reviewed. L. R. SHEPHERD

539.185

8238. Neutron–deuteron scattering at low energies. M. VERDE. *Atti Accad. Naz. Lincei* (*R.C.Cl. Sci. Fis. Mat. Nat.*) **8**, 228–32 (*March*, 1950) *In Italian.*

A preliminary paper deriving formulae for the cattering cross-section on the basis of the method lescribed in a previous paper. See Abstr. 7296 1949). L. PINCHERLE

539.185

8239. The scattering of neutrons by deuterons. S. L. MARTIN, E. H. S. BURHOP, C. B. ALCOCK AND R. L. F. BOYD. *Proc. Phys. Soc., Lond. A*, **63**, 84–97 (*Aug.*, 1950).

The photographic plate method was used. The leuteron recoils were produced in a thin target of eavy wax placed in contact with a C2 Ilford nuclear mulsion. Owing to the short range of the recoils roduced when neutrons of low energy are scattered hrough small angles, the technique is only applicable o the study of the angular distribution in the range 0°–180° in the centre-of-mass system. For angles etween 120° and 180° the results of the present work re in satisfactory agreement with those of previous xperimenters using different methods, and they gree with the theoretical form of the distribution alculated by Buckingham and Massey on the ssumption of ordinary forces between nucleons. his agreement is not decisive, however, since in is region the calculated distributions for ordinary nd exchange forces do not lie far apart. For smaller attering angles where a decisive test could have een made, the method is too inaccurate. For eutrons of energy from 4·0 to 6·0 MeV and from 0 to 9·0 MeV the angular distribution over a uch larger range of scattering angle has been btained. The angular distribution for neutrons attered through angles near 180° appears to be ther steeper than for slower neutrons; but the ratio the differential cross-section at 90° to that at 180° found to be about 0·35–0·40, of the same order for neutrons in the lower energy range. A.

539.185

8240. Experiments on $N - P$ scattering with 260-MeV neutrons. E. KELLY, C. LEITH, E. SEGRÈ AND C. WIEGAND. *Phys. Rev.*, **79**, 96–8 (*July* 1, 1950).

Neutrons produced by 350-MeV protons impinging on Be were scattered by H. The differential scattering cross-section was measured as a function of the scattering angle. A.

539.185

8241. Neutron–proton capture and coherent scattering amplitudes. L. HULTHÉN. Letter in *Phys. Rev.*, **79**, 166–7 (*July* 1, 1950).

539.185 : 537.534.74

8242. Polarization of neutrons and protons by scattering. J. V. LEPORE. *Phys. Rev.*, **79**, 137–42 (*July* 1, 1950).

Neutrons and protons can be polarized by scattering provided there is a spin-orbit interaction between the incident particle and the scattering nucleus. The polarization effect has been found for a nucleus of spin zero allowing for the possibility of resonance scattering. Particular attention has been paid to the resonance scattering of neutrons by He^4 where almost full polarizations can be obtained, together with large cross-sections. The polarization can be detected by a double scattering experiment, since the second scattering will be axially asymmetric with respect to the direction of the first scattered neutron. The existence of this effect and a preliminary treatment of it was first pointed out by Schwinger. The scattering of polarized neutrons by protons has been studied for potentials suggested by the symmetrical, charged and neutral meson theories. The polarization effect on the differential cross-section is negligible for the symmetrical theory, but is significant for the other two. A.

539.185.08

8243. Neutron dose determination by the photographic plate method. E. W. TITTERTON AND M. E. HALL. *Brit. J. Radiol.*, **23**, 465–71 (*Aug.*, 1950).

The photographic plate technique, using B- and Li-loaded emulsions, has been applied to provide a slow neutron personnel monitoring service. The method is simple and economical in operation, and is sufficiently sensitive to reduce the necessary microscope work to insignificant proportions. Fast neutron personnel monitoring can be carried out quantitatively by employing the proton recoil tracks appearing in the same plates if the source is monochromatic in energy. Where fast neutrons of widely differing energies are present simultaneously it is usually a lengthy process to obtain an accurate dose determination. A.

539.185.7

8244. Low energy neutron resonance scattering and absorption. S. P. HARRIS, C. O. MUEHLHAUSE AND G. E. THOMAS. *Phys. Rev.*, **79**, 11–18 (*July* 1, 1950).

Low energy neutron resonance absorption and scattering integrals have been measured, and resonance scattering fractions, Γ_n/Γ, have been determined for about 30 elements. Lightweight odd Z—even N and even Z—odd N isotopes are shown to have similar resonance phenomena. Correlations of level

density and scattering fraction with atomic weight and nuclear type are presented. A.

539.185.7

8245. Total neutron cross-section of vanadium from 10 to 1000 Kev. J. M. BLAIR AND J. R. WALLACE. *Phys. Rev.*, **79**, 28–30 (*July* 1, 1950).

This has been measured with an energy resolution of ± 6 keV. For low energy neutrons the values of the cross-sections fluctuate rapidly, levelling off to an average of about 3 barns above 500 keV. By using a filtering technique a cross-section of 0·0 ± 0·5 barn was measured at 105 keV. A.

539.185.7

8246. Negative energy neutron resonance in Cl^{35}. C. T. HIBDON AND C. O. MUEHLHAUSE. *Phys. Rev.*, **79**, 44–5 (*July* 1, 1950).

The neutron scattering cross-section of Cl has been measured at various energies in the range from 0 to 3 000 eV. These data have been fitted to a one-level Breit–Wigner scattering formula. A single real level (i.e., one of negative energy with respect to binding) in Cl^{36} at − 75 eV is sufficient to account for the observed slow neutron properties of Cl. A.

539.185.7

8247. Total cross-section of hydrogen and carbon for 153 MeV neutrons. A. E. TAYLOR, T. G. PICKAVANCE, J. M. CASSELS AND T. C. RANDLE. Letter in *Nature, Lond.*, **165**, 967–8 (*June* 17, 1950).

A collimated neutron beam, produced by bombarding Be with 171 MeV protons in a cyclotron, was detected by counting recoil protons from a polythene radiator. Three proportional counters, in coincidence, were separated by carbon absorbers arranged so that those neutrons which were detected had an effective energy 153 ± 3 MeV. Attenuation measurements in good geometry, using polythene and carbon attenuators, gave for carbon σ_{total} = 330 ± 3 millibarns, and for hydrogen σ_{total} = 46·7 ± 1·4 millibarns. T. G. PICKAVANCE

539.185.7 : 519.283

8248. Random sampling [Monte Carlo] techniques in neutron attenuation problems. II. H. KAHN. *Nucleonics*, **6**, 60–5 (*June*, 1950).

Two further techniques are described for reducing the number of histories which must be studied in order to attain a reasonable accuracy in a given neutron attenuation problem. The first, "quota sampling," takes advantage of the fact that some histories are obviously much more important than others and should be studied more intensively, while the second, "statistical estimation," consists of extracting the maximum information from the data obtained in a given history. L. R. SHEPHERD

539.185.7 : 539.152.1

Search for energy levels in C^{13}. *See Abstr.* 8162

539.185.7 : 778.34

8249. Nuclear emulsions and the measurement of low energy neutron spectra. N. NERESON AND F. REINES. *Rev. Sci. Instrum.*, **21**, 534–45 (*June*, 1950).

An experiment was performed with Ilford Type *C*2 nuclear emulsion to determine the usefulness of photographic plates for measuring neutron fluxes and spectra by proton recoils in the region of the low energy limit of the emulsion. The results show that the plates give valid data for neutron flux determinations and energy distributions down to a neutron energy of about 0·5 MeV. Below 0·5 MeV the proton recoils give low values for the number of incident neutrons but approximate results can be obtained down to 0·3 MeV by applying a correction factor in this energy region. The experimental results permit a range-energy curve for protons in *C*2 emulsion to be determined for the energy region from 0·2 to 1·5 MeV. Finally, recoil proton energy distributions obtained from neutron irradiations of *C*2 plates at various low energy values are presented and discussed.

STRUCTURE OF SOLIDS 539.2

539.211 : 532.

Surface roughness and contact angle. *See Abstr.* 7779

539.215.4 : 532.

8250. Surface films and particle size determination of powders. V. R. GRAY. *Canad. J. Res. B*, **28**, 277–91 (*June*, 1950).

It has been found possible to spread almost any powder on a water surface in a layer one particle thick and to study its surface pressure/area relation by conventional film balance techniques. A special sprinkler was developed for placing the powder on the surface, and flotation agents were adsorbed on particles which do not normally float. Fine particles needed extended outgassing and drying before they were sufficiently deflocculated. Although all films collapsed more or less readily on compression it was possible to define a point in the compression curve which represented a rigid film. The thickness of this film was a definite fraction of the mean particle diameter, measured by microscopic methods, this fraction varying with ease of agglomeration and with the shape of the particles. This method can be used for measurement of mean particle size and it possesses certain advantages over existing methods for many purposes.

539.216 : 539.

8251. The production and visco-elastic behaviour of Wollaston wires. C. T. TAN AND K. T. CHAO. *Nat. Peking Univ. Semi-Cent. Vol., Math. Phys. Bull. Ser.*, 51–9 (1948).

A method of producing fine Wollaston wires is described. The uniformity of the wires was tested. By means of an oscillating method *in vacuo*, the rigidity modulus and the viscosity coefficient were determined with wires from 10 to 60 μ in diameter. The experimental results show that the rigidity increases while the viscosity decreases with the diameter of the wires. The effect of the surface layer upon the elastic constant is discussed. An attempt is made to explain the similarity in the visco-elastic behaviour between Wollaston wire and glass fibre.

539.217

8252. Ring diffusion in metals. C. ZENER. *Acta Cryst.*, **3**, 346–54 (*Sept.*, 1950).

The concept of hole migration in metals as the mechanism of self-diffusion and of diffusion of substitution-solute atoms has arisen from the apparent failure of other reasonable mechanisms, such as direct interchange, to give heats of activation comparable to those observed. In the present paper it is pointed out that diffusion by direct interchange is only a special case of diffusion by the synchronized cyclic motion of a number of atoms, herein called ring diffusion. General arguments are presented demonstrating that a 4-ring has a lower potential-energy barrier for cyclic motion than has a 2-ring, which corresponds to direct interchange. These general arguments are supported by detailed calculations for the particular case of self-diffusion in copper. It is concluded that such ring diffusion is not excluded by energy considerations. A.

539.217

8253. On the theory of diffusion in metals. F. SEITZ. *Acta Cryst.*, **3**, 355–63 (*Sept.* 1950).

Zener [preceding Abstr.] has generalized the interchange mechanism of metallic diffusion by considering interchange processes in which more than two atoms may change places at once. The position of these calculations relative to those of Huntington and Seitz on the mechanism of diffusion is discussed. It is emphasized that the calculations still favour the vacancy mechanism, although the purely theoretical support is not as overwhelming as it seemed to be previously. The experimental situation is reviewed. It is pointed out that the existing experiments on the Kirkendall effect, which is concerned with the motion of fiducial markers during diffusion, and the diffusion of minor additions in substitutional alloys, strongly support either a vacancy or interstitial mechanism and exclude a direct interchange mechanism as the major contributing process. Taken as a whole the theoretical and experimental evidence supports the vacancy mechanism as previously. Bardeen's derivation of Darken's relations between the chemical diffusion coefficient and the diffusion coefficients of individual atoms is examined somewhat more generally. A.

539.23 : 535.8

8254. The protection of optical glass and aluminium-surfaced mirrors. FLAMANT. *J. Phys. Radium*, **11**, 80–4 (*July*, 1950) *In French.*

The object of this study is the behaviour of films used for increasing or decreasing the reflectivity of glass, and of films likely to be used for protection of metallic deposits, when they are exposed to an atmosphere containing sea-air, at a temperature of 5° C, during a time sufficient to cause deterioration. The fluorides used either as protecting films or for anti-reflection treatment, have a poor resistance, magnesium fluoride giving the best results, but being practically destroyed after about 10 days. Si and especially SiO are practically unalterable when deposited on glass. They give by far the best protection for reflecting surfaces of metallic Al. But this protection disappears eventually owing to breaking of the protective layer which forms an increasing number of fissures through which the attack of the subjacent metal takes place. The difficulty is apparent with all the substances deposited on metal, and in particular with TiO_2. Al films of sufficient thickness obtained under very good conditions of vacuum and cleanliness, on which the natural protective Al_2O_3 film is formed by exposure to air for one month show also good resistance. Processes of rapid formation of the protective film of Al_2O_3 by chemical means have given moderate results. A.

539.231

8255. On the part played by carbon in the formation of thin films. Generalization to other elements and compounds. O. GOCHE, F. BOUILLON AND A. FRÈRE. *Bull. Acad. Roy. Belge Cl. Sci.*, **36** (*No.* 4) 330–9 (1950) *In French.*

The sputtering apparatus, consisting of a cylindrical vacuum chamber placed between the poles of an electromagnet, is briefly described and illustrated. A flow of gas or vapour was maintained through the chamber. Using an Al cathode and various surfaces as anodes, thin films of C were deposited, in the absence of magnetic field, on the surfaces by decomposition of various organic vapours in the discharge. The films were amorphous, very adherent on glass and metal but easily removable from NaCl crystals. Results for sputtered Cu–C mirrors similar to those obtained previously for Ag–C mirrors [see Abstr. 4610 (1950)], are reported. The effect on the spread of the luminous discharge of the longitudinal magnetic field is illustrated. Experiments performed with the magnetic field showed that C, S, Na, Cd and CdO, formed by decomposition of gas, vapour or solid in the discharge, are deposited in amorphous layers and in a manner depending on the impact of the beam on the several surfaces. Ag, Cu, Pt, CuO, ZnO and CdO deposited by sputtering form uniform crystalline deposits independent of the impact of the beam. The results are stated to verify Ditchburn's hypothesis [*Proc. Roy. Soc. A*, **141**, 169 (1933)]. S. WEINTROUB

539.231 : 535.39

8256. Cathodic sputtering apparatus for the production of deposits whose density is controlled during formation. A. ANDANT. *J. Phys. Radium*, **11**, 351–2 (*July*, 1950) *In French.*

The deposits are prepared by cathodic sputtering. The optical density of the deposits is measured during the sputtering (a beam of light passes through the target plate and the metallic cathode which is perforated for this purpose). The apparatus also provides a control of the purity of the gas in the region where the sputtering takes place. A.

539.234

8257. The preparation and structure of thin Al–Ag and Al–Mg films. A. BOETTCHER. *Z. angew. Phys.*, **2** (*No.* 5) 193–203 (1950) *In German.*

The films were prepared by evaporating the alloys *in vacuo*. Their structure was determined by electron diffraction (reflexion and transmission), their electr. resistivity measured, and the effect of heating and

varying the temperature of evaporation on the structure determined. Diagrams of the apparatus, a phase diagram, graphs, and diffraction photographs are shown. R. A. WEALE

539.234

8258. On the oxidation of Al–Mg and Al–Ag films evaporated in vacuo. A. BOETTCHER. *Z. angew. Phys.*, **2** (*No.* 6) 249–51 (1950) *In German.*

See preceding Abstr. Al–Mg films of thicknesses 300 and 500 Å are shown to be free from oxide immediately after evaporation. On heating *in vacuo* oxidation takes place, and is very marked at 320°C. It is possible to obtain surfaces free from oxide also in alloys of high Mg content. Heating Al–Ag to 520°C gives rise to the β' phase, the Al being partly changed into an amorphous oxide. At 660°C the oxidation of Al is complete. Diffraction photographs are given. R. A. WEALE

539.234

8259. Preparation of thin films whose thickness varies in one direction, according to some given law. P. JACQUINOT. *J. Phys. Radium*, **11**, 361–2 (*July*, 1950) *In French.*

These deposits are of interest for the preparation of neutral photometric wedges or anti-diffraction screens ("apodiseurs") for spectrographs. Description of the apparatus constructed at Bellevue, for making them by evaporation *in vacuo*. A.

539.234 : 535.39

8260. Evolution of certain optical properties of very thin metallic films. M. PERROT. *J. Phys. Radium*, **11**, 385–9 (*July*, 1950) *In French.*

The first results obtained with Ag films, of thickness under 10 μ, and deposited on glass by thermal evaporation, have shown that these films undergo, immediately after their preparation, two important changes. The first corresponds to a "spontaneous ageing" of the films in the vacuum; the second one is produced by the action of the gas to which the surface of the films are exposed. When the phenomenon of the spontaneous ageing appears to be completed, one can produce a "reversibility effect" which shows itself in variations of the reflection factors if the films are placed alternately in a vacuum and in air. A systematic study of the changes of the optical properties of targets and films of chemically well-defined nature is in progress. A.

539.234 : 535.39

Optical properties of thin silicon films. *See Abstr.* 7910

539.234 : 535.411

8261. Apparatus for the preparation by vacuum evaporation of variable-colour interference filters. C. DUFOUR. *J. Phys. Radium*, **11**, 353–4 (*July*, 1950) *In French.*

Description of an apparatus for depositing any number of metallic or other films in the shape of a wedge whose angle can be adjusted for each film. Application to the production of interference filters of variable colour. The device used for controlling the thickness of the deposits during evaporation is also described. A.

539.234 : 535.41

8262. Vacuum evaporation apparatus for the metallization of interferometer films. J. ROIG AND DESCAMPS. *J. Phys. Radium*, **11**, 363–5 (*July*, 1950) *In French.*

Ag and Al deposits may be obtained. Characteristic features are: deposition of 2 interferometer films in succession without admission of air; rotation of the films during deposition for uniformity; measurement of the optical density during the operation; the plates are at first protected by shutters which allow preliminary heating of the filament and removal of impurities; the rotation of a single dial controls all the operations. A.

539.234 : 539.6

8263. Some factors influencing the adhesion of films produced by vacuum evaporation. O. S. HEAVENS. *J. Phys. Radium*, **11**, 355–60 (*July*, 1950).

Among the more important are: vacuum obtained; liquid used in pumps and traps; method of cleaning surfaces; temp. of sources and, in consequence, intensity of molecular jet. Their effect on durability and adhesion is under investigation. Preliminary results with Al are described. The properties of Al deposits on evaporated Cr support are also being studied. A.

539.234 : 537.311.31

8264. The electric conductivity and oxidization of evaporated Al layers. A. BOETTCHER AND G. HASS. *Optik*, **6**, 299–309 (*May*, 1950) *In German.*

It was found that the resistance-temperature curve of films deposited on a support at room temperature showed hysteresis effects. If the support was heated at the time of evaporation these effects were eliminated. For films $>$ 300 Å thick the conductivity was that of the bulk metal, while for thinner films it was as much as 10 times smaller. This was found, by electron microscopy, to be due to the thin layers being in the form of small globules and not continuous. On exposure to air, a monomolecular oxide layer was formed within a minute. In about 2 months the thickness of oxide had increased to about 40 Å. Evaporation on to a support which had not been thoroughly cleaned increased the proportion of oxide. A. H. W. BECK

539.24

8265. Cathodic pulverisation [cathodic sputtering] of metals and crystalline structure. F. DEMICHELIS. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **8**, 373–5 (*April*, 1950) *In Italian.*

The crystalline structure of a thin sheet of Au was revealed by cathodic sputtering. Four microphotographs are given. It is suggested that simple evaporation from a pure metal surface should reveal the crystalline structure. An attempt to show this experimentally with Au proved unsuccessful due to experimental difficulties. H. P. MYERS

539.264

8266. X-ray analysis of the swelling of wood pulp in sodium hydroxide solution. L. JÖRGENSEN AND E. RIBI. Letter in *Nature, Lond.*, **166**, 148 (*July* 22, 1950).

539.264 : 539.216

8267. A rotating specimen mount for use with X-ray spectrometer in measuring crystallite orientation of cellulosic and other textile fibers. L. SEGAL, J. J. CREELY AND C. M. CONRAD. *Rev. Sci. Instrum.*, **21**, 431–5 (*May*, 1950).

The quantitative evaluation of crystallite orientation in textile fibres by X-ray methods is discussed. It is found that photographic recording and photometering of the resulting films can be replaced by automatic recording on a strip chart with the aid of an X-ray spectrometer with G.M. counter. The design and details are given for a specimen holder capable of properly positioning and rotating a bundle of fibres in the X-ray beam so that the 002 or other selected diffraction arc passes before the window of the counter. A tentative procedure is outlined for evaluating, with the aid of this apparatus, the crystallite orientation of a bundle of cellulose fibres. Some typical recordings of the intensity curves of the 002 arcs from ramie, cotton and high tenacity rayon are presented. A.

539.264 : 548.736.1

8268. A note on the structure of amorphous carbon. M. MIWA, S. MAMIYA, T. IGARASHI AND Y. ONAI. *J. Phys. Soc. Japan*, **5**, 81–3 (*March–April*, 1950).

Gives results of X-ray diffraction investigation of graphite, C obtained by reduction of CO, retort C, C obtained by decomposition of C_2H_2 and C_6H_6-soot. As the grain diminishes, the reflection by planes oblique to the main axis becomes weaker and weaker and finally fades away. The structure of lines corresponding to (*hk*0)-planes becomes asymmetric. In coarse-grained material the (100) lines are much stronger than (110) lines, the reverse being the case with the amorphous form. The reflection of higher order by the (001)-plane fades rapidly away. The spacing of (001)-planes becomes larger when passing from graphite to C_6H_6-soot. An interpretation of the results is given. F. LACHMAN

539.27

8269. Electron diffraction study of cementite formation in iron. J.-J. TRILLAT AND S. OKETANI. *C.R. Acad. Sci., Paris*, **230**, 2203–5 (*June* 19, 1950) *In French.*

Iron particles were obtained in finely divided form and electron diffraction studies carried out using the transmission method. The mechanism of cementite formation and the influence of heat treatment was investigated accurately by this means.

E. P. WOHLFARTH

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

8270. A simple example of "incompatibility" in classical elasticity and the theory of finite elastic deformations. A. SIGNORINI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) 276–81 (*April*, 1950) *In Italian.*

539.31

8271. Mechanical models for the representation of visco-elastic properties. R. ROSCOE. *Brit. J. Appl. Phys.*, **1**, 171–3 (*July*, 1950).

Models of varying complexity, built of spring and dashpot elements, are frequently used as a simple means of expressing the relation between a particular component of stress and the corresponding component of strain in a visco-elastic material. It is shown that any such model is equivalent to two alternative spring-dashpot models of canonic form. The exclusive use of models in either of these canonic forms is desirable, since it facilitates the interpretation of behaviour and leads to economy in the number of spring and dashpot elements employed. A.

539.32

8272. On Young's modulus and its temperature coefficient of the alloys of cobalt, iron and chromium, and a new alloy "Co-elinvar." H. MASUMOTO AND H. SAITO. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A*, **1**, 17–22 (*May*, 1949).

Using the direct bending method, the least value of the modulus (E) obtained was $14{\cdot}9\times10^5$ kgm cm^{-2} with an alloy of 60% Co, 32% Fe, 8% Cr, and the greatest value $24{\cdot}4\times10^5$ kgm cm^{-2} for 75% Co, 10% Fe, 15% Cr. Temperature coefficients of E, e, are negative over the greater part of this range, but as the % Co is reduced, e passes through zero and becomes positive to reach a maximum value of $+82{\cdot}0\times10^{-5}$ for 53% Co, 37% Fe, 10% Cr. The Co–Fe–Cr alloys of small e have been called "Co-elinvar." A. J. KENNEDY

539.32 : 534.321.9

8273. A new ultrasonic method for determining elastic constants. B. A. RAMACHANDRA. Letter in *Curr. Sci.*, **19**, 148–9 (*May*, 1950).

The crystal is excited by an X cut quartz plate 2 mm thick and the ultrasonic wave is transmitted into a liquid trough. Near a natural frequency of the plate, transmission max. in the diffraction pattern are found and the differences between max. nearly correspond to the longitudinal fundamental of the crystal; thus the velocity and hence the corresponding modulus is calculated. To excite shear waves a Y cut quartz plate is used. J. E. CAFFYN

539.32 : 539.6

8274. Influence of hydrogen on the elasticity and inelasticity of iron and steel. P. BASTIEN AND P. AZOU. *C.R. Acad. Sci., Paris*, **231**, 147–8 (*July* 10, 1950) *In French.*

It is shown that H has only a very slight effect on the elastic and inelastic properties of Fe and very soft steel. The modulus of elasticity is decreased slightly and the damping capacity is similarly increased.

G. O. BAINES

539.32 : 548.0

8275. On Young's modulus of elasticity of single crystals of nickel and cobalt. K. HONDA AND Y. SHIRAKAWA. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A*, **1**, 9–15 (*May*, 1949).

The moduli have been determined by the microscopic measurement of the depression of the mid

points of crystals treating them as small beams under load. The following results were obtained for Ni single crystals: $E_{[100]}$, $[_{110}]$, $[_{111}]$; the 3 principal elastic parameters (assuming the volume compressibility), and the 3 rigidity moduli computed from these parameters. For Co single crystals: E for axes parallel and perpendicular to the hexagonal axis; the principal elastic parameters (assuming the linear compressibility), and the 2 rigidity moduli from these values. It is shown that the relations between the elastic constants (C_{ik}), $C_{12} = C_{44}$ (Ni and Co) and $C_{11} = 3C_{12}$ (Co) do not hold as they do in various other metals.

A. J. KENNEDY

539.373 : 539.26

8276. X-ray determination of slip planes and slip directions. R. W. TURNER, T. L. WU AND R. SMOLUCHOWSKI. *Rev. Sci. Instrum.*, **21**, 440–1 (*May*, 1950).

Methods based on a comparison of distortion of Laue spots are described. A.

539.374

8277. On the inhomogeneous deformation of a plastic lamina in a compression test. R. HILL. *Phil. Mag.*, **41**, 733–44 (*Aug.*, 1950).

A theory is formulated for the calculation of stresses and displacements in a thin sheet of arbitrary shape which is being plastically compressed between parallel plates. Account is taken of inhomogeneous distortion caused by friction or edge constraints. By a transformation the solution is made to depend on that for a certain elastic problem of plane strain. Experimental data in support of the theory is provided by compression tests on long rectangular strips with both fluid and solid lubricants. A new method is suggested for estimating coefficients of friction relevant for cold-working processes. A.

539.374 : 548.0

8278. On the discontinuous elongation of aluminium crystal. I. T. KAWADA. *J. Phys. Soc. Japan*, **5**, 60–3 (*March–April*, 1950).

Extension is performed at constant strain rate with stress recorded by a spring leaf, the movement of which produces a capacitance change, and, eventually, an oscillograph deflection. This is photographed. The deflection leaf movement ratio was usually set at about 8 000. Commercial Al at 200°C gave a smooth curve. Single crystals gave fluctuations of amplitude $< 0{\cdot}5\,\mu$ up to 10% extension for all orientations. These are to be distinguished from "discontinuous jumps." A 4-crystal specimen gave a smooth curve below the critical shear stress and also above about 10% extension (with the exception of a few groups); in between, jumps were observed.

A. J. KENNEDY

539.374 : 548.0

8279. On the discontinuous elongation of aluminium crystal. II. T. KAWADA. *J. Phys. Soc. Japan*, **5**, 64–8 (*March–April*, 1950).

A more detailed account of work on coarse-grained polycrystals (see preceding Abstr.). From 0 to 100°C, there were fluctuations only; from 100 to 350°C jumps occurred, but with decreasing magnitude as the temperature increased; above 350°C the curves were smooth. As the strain rate decreased, jumps were slightly more frequent and of greater magnitude. Different relative orientations of the members indicated a reduction in the number of jumps as the orientation of neighbours became closer. In view of previous results, an attempt was made to find the minimum grain size for which jumps occur: such a border-line specimen is discussed, and it is suggested that the discontinuous jumps must be associated with the distortion near the grain boundary. The number of jumps was not $\propto$ to the number of grain boundaries. The durations of jumps were random, from 25 to 80 msec, and were independent of the jump magnitude. 99·99% Al showed no discontinuities for any kind of specimen (including single crystal), hence impurities are said to be necessary for their occurrence. Results on Al–Zn and Al–Sn alloys are briefly stated. A. J. KENNEDY

539.374 : 548.0

8280. On the discontinuous elongation of aluminium crystal. III. T. KAWADA. *J. Phys. Soc. Japan*, **5**, 68–70 (*March–April*, 1950).

A discussion of experimental results (see preceding Abstr.) based on dislocation considerations and their interaction with the grain boundary. A. J. KENNEDY

539.388.23

8281. On the correlation of the directional properties of rolled sheet in tension and cupping tests. L. BOURNE AND R. HILL. *Phil. Mag.*, **41**, 671–81 (*July*, 1950).

Plastic anisotropy in rolled sheet is examined. The earing positions are correlated with the strain-ratios measured in tension tests at various orientations to the direction of rolling. The materials used are copper giving four ears at 45°, brass giving four ears at 50°, and brass giving six ears at 0° and 60°. A theory of plastic anisotropy due to Hill is found to be in good agreement with the experimental data for materials producing four ears. The theory is extended to describe more complex states of anisotropy. A.

539.4.016 : 666.1.037.5

The physical aspect of glass–metal seals in the electron tube industry. *See Abstr.* 8396

539.5 : 539.8 : 536.48

8282. Impact, tensile and hardness tests of some ferrous alloys including the welded parts, at low temperatures. T. FUKUROI, G. MONNA, N. ISHII AND Y. OKAMATSU. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A*, **1**, 101–6 (*Aug.*, 1949).

The tests indicated on 4 types of steel confirm that Cr–Mn-austenitic steel has the best mechanical properties at temperatures down to −195°C.

G. O. BAINES

539.53

8283. A theoretical investigation of the effect of specimen size in the measurement of hardness. R. HILL. *Phil. Mag.*, **41**, 745–53 (*Aug.*, 1950).

The theory of plane plastic strain due to Hencky and Geiringer is applied to calculating the minimum dimensions that a specimen should have for a valid hardness test. Critical widths and thicknesses are

determined for rectangular specimens indented by flat dies and wedges of any angle. The manner in which the specimen deforms during the indentation is considered in detail. A.

539.56

8284. On the mechanism of cold brittleness in metals. T. SUTOKI. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A*, **1**, 23–8 (*May*, 1949).

The phenomena of brittleness in metals and the determination of transition temperatures from brittle to non-brittle states are described. The relevant theories, based on the work of Mauer and Mailander, and of Heindlhofer, are discussed. The results of impact tests on Fe, steels, Zn and Al from −193°C to 200°C are given. It is found that the transition temperature from a ductile to a brittle failure is not a characteristic property of the metal but is greatly influenced by experimental conditions. An interpretation of cold brittleness and some suggestions for its prevention are offered. C. A. HOGARTH

539.62 : 531.44

The sliding surface. *See Abstr.* 7754

PHYSICAL CHEMISTRY 541

541.1

8285. Radiochemical methods in physical chemistry. L. TORDAI. *Atomics*, **1**, 196–9 (*July*, 1950).

A survey of possible uses of radioactive tracer techniques. H. MILLER

PHASE EQUILIBRIUM CHEMICAL REACTIONS 541.11/.12

541.121 : 536.7

8286. Disproportionation equilibria in alkaline earth ions. N. HUSH. *J. Proc. Roy. Soc. N.S.W.*, **82** (*No.* 3) 229–40 (1948).

Evidence for the existence of disproportionation equilibria involving alkaline earth ions of oxidation state +1 in the vapour, liquid and solid states, and in aqueous and non-aqueous solution, is discussed. It is shown that the lack of general recognition of the existence of these equilibria is inconsistent with experiment. Wherever possible, thermodynamic quantities are calculated, and the role of these equilibria in reactions involving the alkaline earths is indicated, together with important points of connection between their study in organic and inorganic fields, e.g. organic magnesium halides.

H. H. HODGSON

541.123.5

8287. The separation of americium and curium from the rare earth elements. K. STREET AND G. T. SEABORG. *J. Amer. Chem. Soc.*, **72**, 2790–2 (*June*, 1950).

Experiments are described on the separation of americium and curium from rare earth fission products and from each other, by selective elution from packed columns of cation exchange resins. Tracer amounts of Am^{241}, Cm^{242}, Ce^{144}, Pm^{147} and Lu^{172} were deposited on the resin and identified in the eluting solution by their radiation characteristics. Curves show that with 0·25M ammonium citrate or 6M HCl eluting solutions Am and Cm are eluted at the same rate as Pm, but as the concentration of HCl is increased to 13·3M the Am and Cm are eluted well ahead of all the rare earths, thus making complete and rapid separation possible. A slight difference in the rates of elution of Am and Cm results as the HCl concentration is increased so that a method for small separations of Am from Cm is indicated.

W. H. DENTON

541.123.5 : 539.16

8288. The kinetics of isotopic exchange reactions. T. H. NORRIS. *J. Phys. Coll. Chem.*, **54**, 777–83 (*June*, 1950).

An isotopic exchange reaction must proceed toward equilibrium according to a first-order rate law or according to concurrent first-order laws. A discussion is given of the implications of this concept for the experimental study of the kinetics of exchange reactions. Expressions are tabulated for the fraction of exchange equilibrium, F, attained at any time, t, in terms of quantities which are experimentally determinable. A.

ELECTROCHEMISTRY 541.13

541.133.08 : 621.317.331

8289. Gold-plated electrode for measurement of conductance of electrolytes. S. BARNARTT. *J. Electrochem. Soc.*, **97**, 235–6 (*July*, 1950).

Electrodes for conductance measurements by the Kohlrausch method were prepared by electrodepositing finely divided Au over a layer of smooth Au. Their behaviour was studied over the frequency range 1 to 10 kc/s. Polarization resistance at these electrodes was found to be relatively small and in conformity with the Warburg relationship. A.

541.135.5

8290. Temperature coefficient of the electrode potential $Cu/CuSo_{4aq}$. G. PASSOTH. *Ann. Phys., Lpz.*, **7** (*No.* 6) 279–88 (1950) *In German.*

The temp. coeff. of the electrode potential $\Delta\psi$ for the system $Cu/CuSO_{4aq}$ has been determined by the ionization method, and for 0·01 mol. $CuSO_4$ solution is $d\Delta\psi/dT = (17{\cdot}6 \pm 0{\cdot}6) \times 10^{-4}$ volt/deg. The same electrode has also served for measurement of the potential $V_{w/k}$ between two differently tempered Cu

electrodes in 0·01 mol. $CuSO_{4aq}$, viz. $V_{w/k}/\Delta T = (7\cdot7 \pm 0\cdot2)\times10^{-4}$ volt/deg. From both results, the difference of the homogeneous electrical effect in the $CuSO_{4aq}$ dV_0/dT and the temp. coeff. $d\chi_l/dT$ of the potential χ_l between the interior and the surface of the solution is $-9\cdot9\times10^{-4}$ volt/deg. On the assumption that the molecular heats of conversion of Li^+ and Cl^- are zero it follows that $d\chi_l/dT = 13\cdot2\times10^{-4}$ volt/deg., and that the temp. coeff. of the galvanic potential of the system $= 4\cdot4\times10^{-4}$ volt/deg. H. H. HODGSON

541.135.5

8291. Determination of the capacity of the electrical double layer in the mercury-jet electrode. A. RÍUS AND A. MARÍN GORRIZ. *An. Real Soc. Esp. Fis. y Quim.*, **46A**, 55–68 (*Jan.–Feb.*, 1950) *In Spanish.*

After a brief survey of the various methods in use for determining the capacities of the double layer formed in the Hg/electrolyte interphase, e.g. of a polarograph the technique and the apparatus used for the present investigation is described in detail. Contrary to the Hg drop method used in Heyrovsky's original instrument a Hg jet is used. The mechanics of this kind of electrode are studied and formulae are derived for the quantity and speed of the Hg flow and for the length of the jet in their functional relation to the Hg pressure. Also a relation is given for the dependence of the length of the jet on the speed of flow. Special stress is laid on the purity of the electrolyte, the Hg and the whole apparatus. The jet and the sonde used for the measurement are arranged in a H atmosphere in order to prevent oxidation. R. NEUMANN

541.135.5

8292. Determination of the capacity of the double electrical layer of a mercury jet electrode. Study of the intensity-potential curves. The forming of the double layer in the electrode. A. RIUS AND A. MARÍN. *An. Real Soc. Esp. Fis. y Quim.*, **46A**, 93–106 (*March–April*, 1950) *In Spanish.*

The experiments have been carried out in the absence of O. The length of the capillary Hg jet reaches a max. at approx. −1 500 V. The shape of the jet length-potential curve is that of a more or less flattened inverted parabola. The created surface is proportional to $\sqrt{h}$ when h is the pressure of Hg in cm. The double electrical layer is formed on the Hg solely in a region very close to the orifice of the capillary. W. SUMMER

541.135.5

8293. Possible structural dependencies of metal electrode potentials. W. LORENZ. *Z. Naturforsch.*, **5a**, 283–91 (*May*, 1950) *In German.*

The following effects are to be expected: the lowering of the mean work required to remove an atom, observed in very small crystals, means a lower potential; the variation of thermionic work function between crystal faces means that the actual work function of the growth centres must be used; the equilibrium potential is not altered by electrolyte adsorption; only the surface with the most negative potential is a stable equilibrium for a crystal in electrolytic solution; the absolute potential will depart from the theoretical value. A. H. W. BECK

541.135.

8294. Role of indifferent electrolytes in electrode kinetics. K. S. G. DOSS AND H. P. AGARWAL. *J. Phys. Coll. Chem.*, **54**, 804–6 (*June*, 1950).

By studying the kinetics of electrode processes Randles observed that the rate constant for the discharge of the zinc ion depended upon the nature of the indifferent electrolyte used in the experiment. It is shown that the variation in the rate constant can be interpreted plausibly on the basis of the variation of the equilibrium potential of the different systems. A

541.135.

8295. The anode layer in the electrolytic polishing of copper. H. F. WALTON. *J. Electrochem. Soc.*, 97 219–26 (*July*, 1950).

The viscosities and electrical conductivities of solutions of $CuHPO_4$ in aqueous phosphoric acid and phosphoric acid-glycerol-ethylene glycol mixtures were measured with a view to investigating the anode layer formed when Cu is electrolytically polished in these solutions. Dissolved Cu was found to raise the viscosity considerably, the increase being greater in the mixtures with glycol and glycerol than in phosphoric acid alone. The Cu concentration near the anode during electrolysis was measured, and current-voltage relationships were studied using a rotating Cu anode. The effective thickness of the anode layer was estimated to be about 10^{-3} cm. A

541.135.5 : 539.211

8296. Electrolytic polishing. R. AUDUBERT, M. BONNEMAY AND E. LEWARTOWICZ. *J. Rech. Cent. Nat. Rech. Sci.* (*No.* 12) 139–47 (1950) *In French.*

The mechanism of anodic overvoltage in electrolytic polishing is investigated, the electrode potential being measured with respect to a standard electrode (e.g. the saturated calomel electrode, and the example chosen was a rustless steel of composition, Ni 9·9%, Cr 19·3%, Mn 0·6%, C 0·16% and Fe 70%). To avoid the influence of cathodic products on the anodic phenomena, the two electrodes have been separated by a porous diaphragm, the cathode being a Pb plate having 10 times the surface area of the anode. The means for establishing the zone of reproducibility of the anodic potential are described, and the general forms of the overvoltage curves are illustrated by 10 diagrams showing the effect of temperature, position of anode (horizontal or vertical), influence of stirring the electrolyte, and addition of neutral salts. The efficiency of the process is discussed together with theoretical considerations. H. H. HODGSON

541.136

8297. A theory of the galvanic columns. J. PALACIOS. *An. Real. Soc. Esp. Fis. y Quim.*, **46A**, 107–22 (*March–April*, 1950) *In Spanish.*

The potential of a galvanic pile is the result of electrons being emitted from the metal and cations being adsorbed by it. In an electrolyte containing a mixture of cations, the efficient cation will produce

E_{max}. If the efficient cations are those of the electrode metal the potential is expressed by Nernst's formula. Methods for measuring the adsorptive power are given. Predictions can be made as to the interchange of cations between a liquid and a metal. The new theory shows that a metal strongly adsorbs its own cations. W. SUMMER

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14

541.14 : 541.182.5

8298. Chemical effects of ionizing radiation in some gels. M. J. DAY AND G. STEIN. Letter in *Nature, Lond.*, **166**, 146–7 (*July* 22, 1950).

DISPERSIONS . COLLOIDS ADSORPTION 541.18

541.182.3

8299. Electrical analysis of aerosols. M. PAUTHENIER AND R. CHALLANDE. *C.R. Acad. Sci., Paris*, **231**, 114–15 (*July* 10, 1950) *In French.*

It is proposed to make a statistical micro-analysis of some industrial atmospheres containing dangerous dust particles, by means of an instrument based on the principle of a fine wire emitting a corona discharge in a tube traversed by an aerosol; the consequent variations in the flow influencing the precipitation of the particles along the length of the tube, which is otherwise linear. The theory of the instrument is developed. L. J. GOODLET

541.183

8300. Orientated adsorption of salts on collagen. A. L. ZAÏDES. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 6) 1059–61 (1950) *In Russian.*

541.183 : 532.63

8301. Adsorption-desorption hysteresis in relation to capillarity of adsorbents. C. PIERCE AND R. N. SMITH. *J, Phys. Coll. Chem.*, **54**, 784–94 (*June*, 1950).

It is shown that desorption hysteresis does not require prior capillary condensation, but may also occur when adsorbate is held on a plane surface. Hysteresis is found when adsorption occurs by merging of clumps of molecules on separate sites. After clumps merge all molecules are held by forces from all active sites touched by the merged clump. Forces are therefore stronger than when the clumps were separate; the vapour pressures of all molecules are lowered and there is desorption hysteresis. The most common case of hysteresis is when capillaries are filled by the meeting of multilayer films on opposite walls. After the films meet, all molecules are held by surface forces from both walls. Small capillaries may fill by condensation which starts at the narrowest places, owing to effects of both walls on lowering the vapour pressure in the meniscus. Such capillaries undergo no change of the adsorbed layer as condensation proceeds and show no hysteresis. They are designated as Class I. Capillaries which fill by meeting of multilayer films on opposite walls are called Class II. They show hysteresis. Criteria are suggested for the recognition of capillary condensation in adsorption. In some cases it is not possible to tell from isotherms whether or not there is capillary condensation. The validity of using the Kelvin equation to compute pore sizes is discussed. An explanation is offered for the phenomena observed in scanning a hysteresis loop. A.

541.183 : 536.48

Adsorption of He at very low temperatures. *See Abstr.* 7959

541.183 : 536.75

8302. Heats of adsorption. IV. Entropy changes in adsorption. C. PIERCE AND R. N. SMITH. *J. Phys., Coll. Chem.*, **54**, 795–803 (*June*, 1950).

Entropy changes for the adsorption process are computed by the relation $T\Delta S = \Delta H - \Delta F$. It is found that the $T\Delta S$ *vs.* relative pressure curve is characterized by 3 regions. First there is a region of entropy increase as the first molecules are adsorbed in a disorderly array. This is followed by a region of entropy decrease and very orderly arrangement of molecules as the surface becomes covered by a monolayer. Finally, in the region of multilayer adsorption there is a small entropy decrease which approaches zero as p approaches p_0. An interpretation is suggested for the isotherm of water on a plane C surface, the only known example of a Type III isotherm. The first molecules are adsorbed at the most active sites with zero or very small net heats but with a large increase in entropy. On further adsorption there is a larger net heat, due to lateral interactions, and a decrease in entropy. The limitations which may apply to use of the Clapeyron equation for computing heats of adsorption are discussed. A.

541.183.1

8303. Physical adsorption on non-uniform surfaces. F. C. TOMPKINS. *Trans Faraday Soc.*, **46**, 569–80 (*July*, 1950).

The effect of the non-uniformity of an adsorbent surface is discussed in relation to the isotherm obtained in physical adsorption, both for localized and non-localized monolayers. Subject to the approximation that the internal partition function of the adsorbed molecule $j_i(T)$ is independent of the adsorption potential χ_i at the ith sites, it is shown that log pressure against log amount adsorbed will be linear, no matter whether the adsorbed film is regarded as a polyphase or monophase system. A.

541.183.1

8304. Adsorption isotherms for non-uniform surfaces. F. C. TOMPKINS. *Trans Faraday Soc.*, **46**, 580–6 (*July*, 1950).

See preceding Abstr. A general approach to the problems of adsorption on non-uniform surfaces is outlined and, with certain restrictions regarding the magnitude of certain entropy changes, four well-known isotherms are deduced from the variation of heat of adsorption with coverage. A possible guide to the type of non-uniformity existing at the surface is suggested. A.

CHEMICAL STRUCTURE 541.4/.6

541.57

8305. Electrostatic interaction in hydrogen bonding. N. D. COGGESHALL. *J. Chem. Phys.*, **18**, 978–83 (*July*, 1950).

An attempt has been made to calculate the frequency shift, the intensity of absorption, and the energy of association of a hydroxyl group which is a participant in a hydrogen-bonded complex. When a term expressing the polarization energy of a hydroxyl group due to electrostatic interaction is added to the Morse function, the Schrödinger equation may be solved. The calculated wavelength of maximum absorption agrees with the experimental value fairly well for benzyl alcohol and exactly for catechol. Agreement between calculated and observed absorption intensity is satisfactory. The association energy, calculated on the linear polymer model, agrees quite well with the experimental results reported by Mecke. A.

541.57 : 539.132

8306. The logical position of the "average bond energy," the "dissociation energy of a bond," and the "force constant". M. SZWARC AND M. G. EVANS. *J. Chem. Phys.*, **18**, 618–22 (*May*, 1950).

The concepts of "bond dissociation energy" and "average bond energy" are analysed. A mathematical treatment is suggested which makes it possible in principle to distribute the energy of atomization among the various bonds of the molecule. The relationship between the "bond dissociation energy," "average bond energy," and "reorganization energy" is examined in the light of various molecular force fields. A.

541.57 : 539.132

8307. Electron affinities of some aromatic molecules. L. E. LYONS. Letter in *Nature, Lond.*, **166**, 193 (*July* 29, 1950).

541.64

8308. Degree of polymerization and chain transfer in methyl methacrylate. S. BASU, J. N. SEN AND S. R. PALIT. *Proc. Roy. Soc. A*, **202**, 485–98 (*Aug.* 22, 1950).

541.66 : 542.952.6

8309. Cohesion and polymerization of polyvinyl chloride from its specific heat. M. BADOCHE AND LI-SHU-HUA. *C.R. Acad. Sci., Paris*, **231**, 50–2 (*July* 3, 1950) *In French.*

It was found in accordance with Berthelot's theory that up to 70° the increase of the specific heat of polyvinyl chloride is independent of the degree of polymerization, while above 70°, as temperature rises, the specific heat increases the more slowly the higher the degree of polymerization. F. LACHMAN

CHEMICAL ANALYSIS 543/545

545.37

8310. Reversibility and irreversibility of electrode reactions in oscillographic polarography. The validity of the wave height equation. P. DELAHAY. *J. Phys. Coll. Chem.*, **54**, 630–9 (*May*, 1950).

The equations obtained by Randles and by Sevcik for the height of an oscillographic polarogram have been recalled. After transformation these equations were found to be identical except for a difference in a numerical constant. Several of the factors appearing in the equation have been investigated experimentally. For a reversible electrode reaction Randles' equation was found to be correct. For an irreversible electrode process the rate of the reaction is a controlling factor of the current and the experimental results cannot be predicted by Randles' equation. The dependence of the wave height on the rate of the electrode reaction is interpreted in terms of the free energy of activation of the electrode process involved. Experimental implications of the reaction rate dependence are discussed. It is concluded from the experimental data that some electrode processes which are usually considered as occurring reversibly, actually involve a small free energy of activation. A.

545.7 : 537.228.

8311. Analysis of gases by electrostriction method. H. SENFTLEBEN AND H. GLADISCH. *Z. angew. Phys.*, (*No.* 5) 204–5 (1950) *In German.*

Describes a method of determining the composition of mixtures of gases, based on the cooling effect of gas currents caused by electrostriction. The apparatus used is suitable for both single measurements and continuous recording. F. LACHMAN

545.83

8312. Report of discussion on calibration line drift in spectrographic analysis—Sheffield, February 1950. H. R. CLAYTON AND E. VAN SOMEREN. *Brit. J. Appl. Phys.*, **1**, 157–8 (*June*, 1950).

545.822

8313. The application of the cathode ray tube to microphotometry of trace elements. H. M. DAVIS AND R. J. WEBB. *Spectrochim. Acta.*, **4** (*No.* 1) 13–20 (1950).

The apparatus described is designed as an accessory to a non-recording microphotometer for the purpose of presenting a picture of the blackening contour of a portion of a spectrogram on the screen of a cathode ray tube. Although of general application, its principal function is the detection and estimation of trace elements in complex spectra, when normal non-recording microphotometry and visual methods are difficult or impracticable. A method for the quantitative interpretation of the contours and particular implications of this aspect of microphotometry are discussed. A.

545.822 : 535.243

8314. A rapid and accurate method of measuring line intensities in spectrochemical analysis. N. W. H. ADDINK. *Spectrochim. Acta.*, **4** (*No.* 1) 36–42 (1950).

The method is based on visual comparison with standard density lines (standard paper density scale) and gives results as accurate as those obtained by the densitometer (5%); it includes a correction for background intensity. It speeds up quantitative analysis, as the qualitative inspection of the spectrum and the measurement of line intensities can be made simultaneously; the use of a densitometer is elimi-

nated. Examples of analysis results and of the time necessary for quantitative analysis according to this method are given. A.

545.824

8315. Chemical analysis by means of X-rays. IV. A quantitative analytical method using a standard density. L. Rivoir Alvarez. *An. Real Soc. Esp. Fis. y Quím.*, **46A**, 77–82 (*March–April*, 1950) *In Spanish.*

The concentration of an element in the anticathode of an X-ray tube is directly proportional to the photographic density produced by the characteristic X-radiation of this element. Two photographs must be taken. One displays the density $S_1 = kx$ where x is the unknown quantity of the element in the anticathode. The other photograph shows the density $S_2 = k(x + c)$ and is due to the anticathode now containing a mixture of $x + c$, where c is a known quantity of the same element. From these two equations x can be calculated. The electrical data of the X-ray tube must be kept constant during each set of tests. W. SUMMER

545.827

8316. Punched card catalog of mass spectra useful in qualitative analysis. P. D. Zemany. *Analyt. Chem.*, **22**, 920–2 (*July*, 1950).

CRYSTALLOGRAPHY 548

548.0

8317. On isomorphism and morphotropy in a number of crystals. $X_2Sb(pC_6H_4CH_3)_3$. [X = F, Cl, Br, I]. G. S. Zhdanov and Z. P. Razmanova. *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 6) 1055–7 (1950) *In Russian.*

548.0 : 535.343.2

8318. Theory of color centers in ionic crystals. I. T. Inui and Y. Uemura. *Progr. Theor. Phys.*, **5**, 252–65 (*March–April*, 1950).

The potential field in the vicinity of the *F*-centre in alkatihalides is critically discussed and on this ground a simple model of rigid lattice introduced. Two methods of approach—the continuum model and large molecule model—have been employed. By use of the variation principle, the electronic states of *F*-centre are calculated for several models proposed here. The results of calculation show that the calculated energy approaches the observed ones as the precision of the model increases. The method of formulating the effect of polarization is considered, and the relation of the authors' model to that of Tibbs discussed. A.

548.0 : 535.343.2

8319. The discolouration of alkali halide crystals by irradiation. H. Dorendorf and H. Pick. *Z. Phys.*, **128** (*No.* 1) 166–71 (1950) *In German.*

Single crystals of various alkali halides were irradiated with X-rays, γ-rays or fast electrons, and the absorption spectrum in the range 200 mμ to 700 mμ measured. Near the *F*-band in the visible an absorption band in the form of an ultraviolet resonance was observed (*V*-band). This *V*-band possesses many similar features to the *F*-band. The *V*-centres are identified as atomic halogen distributed throughout the crystal together with defect electrons in a cation deficiency. C. A. HOGARTH

548.0 : 535.55 : 537.228.3

8320. Optical properties and the electro-optic and photoelastic effects in crystals expressed in tensor form. W. P. Mason. *Bell. Syst. Tech. J.*, **29**, 161–88 (*April*, 1950).

Maxwell's electromagnetic equations are written in tensor form for a non-isotropic non-magnetic medium, and the velocity of propagation a plane wave is found and related to Fresnel's ellipsoid. The differential of the internal energy is written, again in tensor form, with the elastic stresses, the electric field and the temperature as dependent variables, and the differentials of the strains, displacement and entropy as the independent variables. This is applied to derive the isentropic relations between the electro-optic effect and the photo-elastic effect, and the forms taken by the 3rd-rank electro-optic tensor and the 4th-rank photo-elastic tensor are given for each crystal class. The photo-elastic effect in isotropic solids is also discussed, in view of its importance in experimental stress analysis.

A. J. C. WILSON

548.0 : 535.6 : 541.135.5

8321. The bleaching of potassium chloride by electrical means. G. Heiland. *Z. Phys.*, **128** (*No.* 1) 144–65 (1950) *In German.*

Experiments on the motion of colour centres in KCl with different electrodes were performed. A Pt or W wire fitted with a Supremax glass seal was used as cathode (Flusselektrode) and a graphite layer as anode (Sperrelektrode). The combination of a pointed with a disc electrode gave a regulation of current strength. The motion of *F*-centres was studied by both electrical and optical means and theoretical expressions are given for both varying and steady-state conditions. Uniform discolouration is only possible in a limiting case where diffusion losses are negligible, i.e. for high voltages, low temperatures and large crystal cross-section. The results are related to the work of Karabascheff and Mollwo.

C. A. HOGARTH

548.0 : 537.228.1 : 539.32

8322. Determination of the elastic and piezoelectric coefficients of monoclinic crystals, with particular reference to ethylene diamine tartrate. R. Bechmann. *Proc. Phys. Soc., Lond. B*, **63**, 577–89 (*Aug.*, 1950).

The dynamic determination of elastic and piezoelectric coefficients of crystals belonging to the monoclinic sphenoidal class is discussed using the longitudinal mode of vibration for narrow bars, low-frequency longitudinal and face-shear modes for square plates containing the axis of symmetry, coupled modes for square plates perpendicular to the axis of symmetry and the thickness-shear mode for plates containing the axis of symmetry. A new set

of values for the elastic and piezo-electric coefficients and their temperature coefficients for ethylene diamine tartrate is given based on this method. Some properties are considered of face-shear vibrating square plates of ethylene diamine tartrate rotated about the axis of symmetry as functions of the orientation, and of Y-cut plates as functions of the breadth–length ratio. A.

548.23

8323. The effect of the free surface on the deformation [of a crystallite] in polycrystalline material. F. Vitovec and A. Slibar. *Schweiz. Arch. angew. Wiss. Tech.*, **16**, 76–80 (*March*, 1950) *In German.*

This is estimated quantatively in terms of the number per unit volume and dimensions of the crystallites by considering the influence of neighbouring crystallites. Within a surface layer of approx. 15 crystallite diameters thick, the deformation is a decreasing function of the distance of the crystallite from the surface. J. E. CAFFYN

MOLECULAR AND X-RAY CRYSTALLOGRAPHY *548.7

548.7

8324. Order-disorder in hexagonal lattices. R. M. F. Houtappel. *Physica*, **16**, 425–55 (*May*, 1950).

Some relations for the partition functions of 2-dimensional infinite triangular and honeycomb lattices with Ising interaction between neighbours without magnetic field are given in the general case of different interactions in the 3 directions. Exact evaluation of these partition functions is obtained with the aid of the method of Bruria Kaufman. The theory of this method is simplified by avoiding the use of abstract group-properties. Some thermodynamic properties of the isotropic hexagonal lattices are given. These are compared with the corresponding properties of the quadratic lattice. All honeycomb and nearly all triangular lattices have a transition temperature. At this temperature the energy is continuous and the specific heat becomes infinite as $-\ln|T-T_c|$, as in the rectangular case, solved by Onsager and Kaufman. There are exceptional triangular lattices without transition temperature: for example those with equal negative interactions. A.

548.7

8325. Anharmonicity of the lattice oscillations in the alkali halide crystals. K. Krishnan. Letter in *Nature, Lond.*, **166**, 114–15 (*July* 15, 1950).

548.7 : 519.281.1

8326. Note on the theory of the frequency spectrum of crystalline solid. T. Nakamura. *Progr. Theor. Phys.*, **5**, 213–23 (*March–April*, 1950).

To examine the accuracy of Houston's method of approximation for calculating the frequency spectrum of crystalline solid, the approximate frequency spectrum of square lattice obtained from this method is compared with the exact one obtained from Montroll's method. Near the origin the curve obtained from Houston's approximation agrees fairly exactly with the accurate curve, while its slope becomes too steep as the frequency approaches t first peak. The portion of this approximate curve the right of the first peak has no physical significan The frequency distribution function consists of t or more analytically different parts. If the applicati of Houston's method to such parts is attempt separately, the frequency distribution function wi out spurious peaks will be obtained. And it important to investigate the topological properties the curve of equal frequency in the Brillouin zone that the calculation may be made by this method.

548.7 : 536

8327. The crystallography and thermodynamics order-disorder transitions in certain mixed keton V. Daniel. *Phil. Mag.*, **41**, 631–52 (*July*, 1950).

Theoretical treatment is given of the therm dynamic stability of different configurations of ke groups in mixtures of equal amounts of equivale ketones [cf. Oldham and Ubbelohde, *Trans Far. So* **35**, 328 (1939); Abstr. 2732 (1940)]. It is assum that keto groups contribute to the bonding only d to their dipole moment. Different mixtures of equivalent ketones of chain-length 18 were examin experimentally. Two kinds of order-disorder tran tions occur in these mixtures. The conditions stability of the different configurations of keto grou are in agreement with theory propounded. T binding energy of a plane array of keto groups c be derived from transition temperatures, and agrees with the value obtained by Fröhlich [Abs 2117 (1946)] for the electrostatic interaction in th array. F. LACHMA

548.734

8328. A graphical method of indexing powd photographs of cubic substances and of determini unit-cell dimensions. J. C. de Wijs. Commun. *Acta Cryst.*, **3**, 394 (*Sept.*, 1950).

548.734

8329. A graphical method of estimating absorpti factors for single crystals. R. G. Howells. *Ac Cryst.*, **3**, 366–9 (*Sept.*, 1950).

An accurate method of estimating absorpti factors for oscillation photographs of single cryst of constant cross-section is given, the computati being comparatively short for crystals of lar absorbing power. The method is applicable to bo zero and non-zero layer lines. It is also extended zero-layer-line reflections in two special cases crystals of varying cross-section, viz. (1) that of pyramidal form, and (2) that of a needle with i length perpendicular to the rotation axis.

548.734

8330. Crystal orientation on the Weissenber goniometer. H. Winchell. Commun. in *Ac Cryst.*, **3**, 396 (*Sept.*, 1950).

548.7

8331. Largest likely values for the reliability inde A. J. C. Wilson. Commun. in *Acta Cryst.*, **3**, 397 (*Sept.*, 1950).

548.7

8332. Reliability index for centrosymmetric an non-centrosymmetric structures. D. C. Phillip D. Rogers and A. J. C. Wilson. Commun. *Acta Cryst.*, **3**, 398–9 (*Sept.*, 1950).

548.735.4

8333. Remarks on the theory of phase limiting inequalities and equalities. J. A. GOEDKOOP. *Acta Cryst.*, **3**, 374–8 (*Sept.*, 1950).

Inequalities derived by Karle and Hauptman are discussed in more detail. The simplifications resulting from symmetry are studied, and it is shown that the relations derived by Harker and Kasper [Abstr. 3015 (1948)] are only those that correspond to the totally symmetric representation of the point group. In the discrete-atom approximation, part of the inequalities reduces to equalities, special cases of which have been reported earlier. A.

548.736.1 : 541.57

8334. The covalent bond in diamond and the X-ray scattering factor of covalent-bound carbon. R. BRILL. *Acta Cryst.*, **3**, 333–7 (*Sept.*, 1950).

By Fourier synthesis it was found that the change which a carbon atom undergoes in forming a covalent bond consists in concentrating about $\frac{1}{2}$ to $\frac{3}{4}$ of one electron of the outer shell in every chemical bond. An X-ray atomic scattering curve is given for the covalent-bonded carbon atom. A.

548.736.3

8335. The formation and crystal structure of silicon carbide. A. TAYLOR AND D. S. LAIDLER. *Brit. J. Appl. Phys.*, **7**, 174–81 (*July*, 1950).

The presence of cubic β–SiC has been identified by X-ray photographs when graphite and silicon are heated together at temperatures as low as 1 150°C, and when vitreous silica is heated with graphite the carbide is formed at 1 450–1 475°C, probably by a vapour phase reaction. No matter how the starting materials may be varied in nature and in proportion, face-centred cubic carborundum is always formed, unless the temperature is in the region of the decomposition point. Near 2 000°C face-centred cubic carborundum begins to decompose, as shown by the presence of graphite lines in an X-ray photograph, and lines corresponding to the hexagonal modification II appear. Light green commercial carborundum shows faint graphite lines when heated at 2 000°C, while at 2 050°C it turns black and a large amount of macrocrystalline graphite is formed. The long soaking periods, high vapour pressure, and high temperature conditions occurring in commercial processes favour the formation of large crystals of modification II. The evaluation of the Debye–Scherrer photographs from commercial silicon carbides shows that the elementary tetrahedra which form the basis of the structures are slightly distorted, being expanded in the c direction and compressed in the direction of the a-axis. A possible wurtzite type, not so far reported in the literature, was looked for, but without success. A.

548.736.3

8336. Silicon carbide of 594 layers. G. HONJO, S. MIYAKE AND T. TOMITA. Commun. in *Acta Cryst.*, **3**, 396–7 (*Sept.*, 1950).

548.736.4

8337. X-ray study of masuyite. H. BRASSEUR. *Bull. Soc. Roy. Sci. Liège*, **19**, 239–41 (*May*, 1950) *In French.*

Orthorhombic, *Pcna*, $a = 14{\cdot}06$, $b = 12{\cdot}06$, $c = 14{\cdot}24$ *kX*. A. J. C. WILSON

548.736.4

8338. High-temperature X-ray study of the system Fe_3O_4–Mn_3O_4. H. F. MCMURDIE, M. SULLIVAN AND F. A. MAUER. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 35–41 (*July*, 1950).

A series of compositions in the system Fe_3O_4-Mn_3O_4 was prepared and examined at high temperatures by X-ray diffraction methods. Although Fe_3O_4 and Mn_3O_4 form a continuous series of substitutional solid solutions stable at room temperatures, those compositions containing less than 60% of Mn_3O_4 are cubic, of the spinel type, and the rest are tetragonal. Those compositions that are tetragonal at room temperature pass through a two-phase region when heated and acquire the cubic spinel-type structure at high temperatures. The temperature range of the two-phase (exsolution) region varies with composition. The relation to this system of the minerals vredenburgite and hausmannite is discussed. A.

548.736.4

8339. X-ray diffraction study of cerous phosphate and related crystals. I. Hexagonal modification. R. C. L. MOONEY. *Acta Cryst.*, **3**, 337–40 (*Sept.*, 1950).

The phosphates of trivalent lanthanum, cerium and neodymium have been found to be dimorphic. One phase is monoclinic, isomorphous with the mineral monazite; the other is a hexagonal structure of a new type which easily converts to the monoclinic form at moderately high temperatures. The hexagonal modification crystallizes with the symmetry of D_6^4–$C6_22$. There are three molecules of XPO_4 in the unit hexagonal cell, where X may be La, Ce or Nd. The cell dimensions of the three crystals have been determined, and the complete structure has been deduced. In this structure X is co-ordinated to eight oxygen atoms—four at 2·34 Å and four at 2·66 Å—in such a manner as to leave open oxygen-lined channels along the hexagonal axis. The presence of zeolitic water in these channels [$XPO_4(0$–$0{\cdot}5H_2O)$] is probably necessary to stabilize the structure. A.

548.736.4

8340. On the crystal structure of sodium thioantimonate, $Na_3SbS_4 . 9H_2O$ (Schlippe's salt). A. GRUND AND A. PREISINGER. *Acta Cryst.*, **3**, 363–6 (*Sept.*, 1950) *In German.*

Powder diagrams show the crystals to be cubic with $a = 11{\cdot}96 \pm 0{\cdot}02$ Å, $n = 4$. The space group was taken to be $P2_13$–T_4, and atomic positions were assigned by trial-and-error methods based on considerations of co-ordination and on a comparison of observed and calculated intensities for 118 reflections. The four Sb atoms are tetrahedrally surrounded by S at 2·37 Å. Eight of the Na atoms are surrounded by 6 H_2O at $2{\cdot}46 \pm 0{\cdot}03$ Å, and the remaining 4 Na by 3 S at 2·91 Å and 3 H_2O, both octahedra about Na being deformed. The S–H_2O distances lie between 3·15 and 3·52 Å. A.

548.736.4

8341. On the structure of basic salts with pseudo-hexagonal layer lattices. F. AEBI. *Acta Cryst.*, **3**, 370–2 (*Sept.*, 1950) *In German.*

It is shown that a number of basic salts with the

formula $MeX_2,3Me(OH)_2$ or $Me_2X(OH)_3$ crystallize in layer structures, related to the hexagonal *C6*- or $Mg(OH)_2$-type. This relation is described in the case of $CuBr_2,3Cu(OH)_2$, whose structure has recently been determined. Further, an unstable modification of $CuCl_2,3Cu(OH)_2$ is found to be isotypical or isomorphous with the bromide, and its cell dimensions are given. Lastly, the structure of $CoBr_2,3Co(OH)_2$ is discussed, with the result that it also is related to the layer structure of the type described, but probably in a more complicated manner. A.

548.736.4

8342. Remarks on the structure of ammonium tetrametaphosphate. K. R. Andress and K. Fischer. Commun. in *Acta Cryst.*, **3**, 399–400 (*Sept.*, 1950) *In German.*

548.736.6

8343. The determination of the crystal structure of tourmaline. G. Donnay and M. J. Buerger. *Acta Cryst.*, **3**, 379–88 (*Sept.*, 1950).

548.737

8344. The crystal structure of cytidine. S. Furberg. *Acta Cryst.*, **3**, 325–33 (*Sept.*, 1950).

548.737

8345. The crystal structure of tartaric acid. F. Stern and C. A. Beevers. *Acta Cryst.*, **3**, 341-6 (*Sept.*, 1950).

The structure of the optically active form of tartaric acid has been determined by Patterson and Fourier methods. The molecule is found to have essentially the same configuration as the tartrate ion in Rochelle salt, containing two planar $=C.OH.COOH$ groups inclined to each other at an angle of about 63°. Molecules are linked to each other by hydrogen bonds which show a strong tendency to lie in the planes of the flat $=C.OH.COOH$ groups. A.

548.737

8346. The crystal structure of α-D-glucose. T. R. R. McDonald and C. A. Beevers. Commun. in *Acta Cryst.*, **3**, 394–5 (*Sept.*, 1950).

548.74

8347. Magnetite inclusions in mica. D. A. Richards. *Proc. Phys. Soc., Lond. A*, **63**, 852–5 (*Aug.*, 1950).

The paper describes the investigation of the orientation of magnetite inclusions in mica using electron diffraction by transmission through composite films. The diffraction pattern obtained indicates that the magnetite is a single crystal with its (111) planes parallel to the cleavage plane of mica and one of the face diagonals parallel to the *b* axis of mica. The technique for preparing the thin films is described in some detail. A.

GEOPHYSICS 55

550.16

8348. Causes of motions in the earth's core. W. M. Elsasser. *Trans Amer. Geophys. Un.*, **31**, 454–62 (*June*, 1950).

The geomagnetic secular variation can be interpreted as the expression of motions in the fluid, electrically conducting core. The investigation of the possible causes of such motions shows that thermal convection provides the only satisfactory mechanism for the generation of motions. If 5–10% as much radioactivity as that contained in the crust is concentrated in the central region of the earth inside the Lehmann–Gutenberg discontinuity, convection in the fluid core will take place. A study of the lunar perturbations of the core, tidal, precessional and others shows that these effects should be negligible in the generation of motions as compared to the thermal effects. A.

550.24

8349. On earth tides. E. Nishimura. *Trans Amer. Geophys. Un.*, **31**, 357-76 (*June*, 1950).

A value is obtained for the effective modulus of rigidity of the earth's upper mantle by using vector differences between tiltmetric observations at two suitably selected stations. By this method, the direct effects of earth tides are almost entirely eliminated and the oceanic effects are accurately evaluated. With regard to the particular motion of the earth's surface near an active fault, anomalous tilting diagrams obtained at 6 closely spaced stations near the sea are discussed in relation to the geologic structure of the surface ground. Rigidity of the earth as a whole is analysed. A value of $1 + k - h$ is obtained from tiltmetric observations at a stable station far remote from the oceans, and values of the effective rigidity for the whole mantle and for the whole earth are determined. From data over long periods at 6 International Latitude Observatories, tidal latitude variations are analysed and used to determine values of $1 + k - l$. Unexplainable effects peculiar to the observing stations and to the epoch adopted in analysis are noted. From data resulting from 300 000 pairs of star observations, the mean value of L was estimated as 1·20. The time variation of the elasticity of the earth's crust is analysed. An unusually large variation with time in the earth tidal amplitude observed at Makimine is discussed and is considered to be intimately related to the bending of the earth's crust caused by the load of sea water in the nearby Hyûganada, an active centre of large-scale sea earthquakes. The elastic anisotropy of the earth's upper mantle is studied. From an analysis of tiltmetric data obtained at several stations in Japan, it is suggested that the elasticity of the earth's upper mantle in the N–S direction is 20–30% smaller than that in the E–W direction. A.

550.3 : 525.35

Indication of correspondence between geophysical phenomena and the motion of the pole. *See Abstr.* 7722

550.34.08

350. The electronic seismograph. J. A. VOLK AND . ROBERTSON. *Bull. Seism. Soc. Amer.*, **40**, 81–93 *April*, 1950).

A description of the instruments at the tripartite tation at Florissant for the study of microseisms aving periods of about one-half second. The eismometers comprise an electromagnetically damped late attached to the pendulum arm moving between wo parallel fixed plates wired up to form two arms f an R.F. bridge. The R.F. generator, the seismo- neter, the amplifier, detector and recording system re described in detail. J. M. HOUGH

550.38

351. The effect of the compressibility of the earth n its magnetic field. C. TRUESDELL. Letter in *Phys. Rev.*, **78**, 823 (*June* 15, 1950).

550.381

352. Measurement of the earth's magnetic field at igh altitudes at White Sands, New Mexico. E. MAPLE, W. A. BOWEN AND S. F. SINGER. *J. Geophys. Res.*, **55**, 115–26 (*June*, 1950).

An Aerobee rocket containing a total-field magneto- neter was fired, and telemetered data gave a record of he earth's magnetic field during the flight. The ecorded decrease in field was 28 milligauss (mG) at 68 000 ft, which agreed with dipole calculations to vithin 2 mG. This was the first step in an attempt to btain direct experimental evidence of postulated urrent-sheets in the upper atmosphere. The flight vas intended chiefly as a test of the method and nstrumentation, and was made at White Sands ecause of existing facilities there. The location was nfavourable to the ultimate purpose of the experi- nent, and no evidence of magnetic fields caused by urrent-sheets was obtained. The results show, owever, that the method is adequate for detection f the predicted effects at more favourable geo- nagnetic latitudes. A.

550.383

353. The experimental determination of the geo- nagnetic radial variation. S. K. RUNCORN, A. C. ENSON, A. F. MOORE AND D. H. GRIFFITHS. *Phil. Mag.*, **41**, 783–91 (*Aug.*, 1950).

Theories of the origin of the dipole components of he earth's main magnetic field are of two types; listributed theories attribute it to a fundamental roperty of rotating matter, core theories to current ystems within the core. The variation with depth elow the surface of the horizontal field intensity is ifferent for the two theories. Experimental values re given for this variation, obtained by measure- nents in coal mines, which are near to the values redicted by a core theory, and significantly different rom those predicted by a distributed theory. The nagnetic effects of the sedimentary rocks and magnetic nomalies due to the basement rocks are shown to ave negligible results on the measurements. A.

551.463 : 535.34

354. Ultra-violet radiation in the sea. N. G. ERLOV. Letter in *Nature, Lond.*, **166**, 111–12 (*July* 15, 950).

ATMOSPHERE . METEOROLOGY 551.5

551.508 : 539.16

8355. The use of radioisotopes for the measurement of the water equivalent of a snow pack. R. W. GERDEL, B. L. HANSEN AND W. C. CASSIDY. *Trans Amer. Geophys. Un.*, **31**, 449–53 (*June*, 1950).

A radio-telemetering snow gauge has been designed which uses the principle of absorption by water (liquid or solid phase) of the gamma emissions from an artificial radioactive isotope. The radioactive, radio-telemetering snow gauge has been used successfully to measure up to 55 water equivalent inches of snow by counting the pulses from a suitably located G.M. tube. These pulses have been successfully transmitted and relayed by radio. Further progress is dependent upon the development of a reliable radio communication system for use with the radioactive snow gauge in remote high mountain areas.

551.509.33

8356. Results obtained in long range forecasting. L. DUFOUR. *Inst. Roy. Met. Belge, Misc.* (*No.* 39) 3–28 (1950) *In French.*

The methods used in the U.S.A. meteorological service consist first of an analysis to determine the zonal indices, isotherms and isobars with the centres of action in the atmosphere. In preparing forecasts for a 5-day or longer period the zonal indices must be forecast, prognostic charts prepared, and also charts of anomalies of temperature and precipitation. These methods are fully described. It is concluded that the procedure has a serious scientific basis and that the empirical part of the process will decrease. The 5-day forecasts when tested regionally in U.S.A. show a 67% accuracy and are used by firms in a practical way. Suggestions show how such a scheme could be adopted in Europe. R. S. READ

551.510.535 : 537.568

Recombination coefficient of the *F* layer. *See Abstr.* 8078–9

551.510.535 : 621.396.677

8357. A 600-ohm multiple-wire delta antenna for ionosphere studies. H. N. CONES, H. V. COTTONY AND J. M. WATTS. *J. Res. Bur. Stand., Wash.*, **44**, 475–88 (*May*, 1950).

Describes the design and the performance of an aerial developed for use with high output impedance, vertical-incidence ionosphere sounding equipment. Graphs show its terminal impedance over the separating frequency range (1–25 Mc/s), using various lengths of open-wire transmission line. The results of pattern measurements using model techniques are given, showing the expected radiation characteristics of the full-scale aerial. Ionosphere records obtained using this aerial are compared with those obtained by the use of a larger aerial developed previously. A.

551.511 : 551.515.11

8358. On the theory of large-scale vortex motion in the atmosphere. R. W. JAMES. *Quart. J. Roy. Met. Soc.*, **76**, 255–76 (*July*, 1950).

A consideration of the parameters best suited to characterizing a circular vortex leads to the conclusion that an intensity factor, the central pressure

defect (or excess) and a scale, or size factor are fundamental. General expressions are given for the mass defect of a cyclone, its total potential energy and the total kinetic energy of geostrophic winds. A dimensionless measure of the "flexure" or bending of a pressure profile is shown to vary relatively slightly from cyclone to cyclone, suggesting that the profile shape is roughly the same for all symmetrical lows. The kinetic energy arising from ageostrophic components of wind are also discussed. It is shown how elliptical vortices, troughs and wedges may be treated, and a "front" is shown formally to be representable as a line distribution of circular vortices. On the basis of the models introduced, a dynamic theory of quasi-geostrophic vortex interaction is put forward which leads to the conception of a potential barrier inhibiting the over-close approach of two vortices, and permits vortex interaction to be conceived as the motion of attracting and repelling "centres of action." A.

551.513

8359. Entrainment and the maximum height of an atomic cloud. L. MACHTA. *Bull. Amer. Met. Soc.*, **31**, 215–16 (*June*, 1950).

With the assumptions of (1) the mixing of the environment's air with that of the cloud by entrainment into the rising cloud, and (2) the environment's having a lapse rate other than the dry adiabatic, the height (H) where the cloud is no longer warmer than its surroundings and is at rest, is given by

$$H = \frac{1}{\frac{1}{M}\frac{\partial M}{\partial z}} \log_e \left\{ \frac{\frac{1}{M}\frac{\partial M}{\partial z}}{\frac{\partial \theta'}{\partial z}} \left[(\Delta\theta)_0 + \frac{\frac{\partial \theta'}{\partial z}}{\frac{1}{M}\frac{\partial M}{\partial z}} \right] \right\}$$

where M is the mass of the cloud, and θ and θ' the potential temperature of the cloud and environment respectively. Numerically the result agrees well with observed values. R. S. READ

551.513

8360. Note on "Entrainment and the maximum height of an atomic cloud" by L. Machta. O. G. SUTTON. *Bull. Amer. Met. Soc.*, **31**, 217–18 (*June*, 1950).

An outline is given of a communication supplied in expanding a simple treatment for a point source of heat, generated at ground level, in an atmosphere of uniform potential temperature, the problem then being one of natural convertion. The mean excess temperature of the sphere at any level z is given by

$$\overline{\Delta\theta} = \frac{4Q}{9c_p\rho\pi^{3/2}C^3z^{3m/2}} + \left(\frac{3m}{3m+2p}\right)az^h$$

where C is the generalized coefficient of diffusion, ρ the density, c_p the specific heat at constant pressure and m the parameter expressing the intensity of mixing ($1 \leqslant m \leqslant 2$). With certain assumptions this expression leads to a height for the atomic cloud at rest of the right order of magnitude. R. S. READ

551.524.7 : 551.576.11

8361. The temperatures at the tops of radar echoes associated with various cloud systems. R. F. JONES. *Quart. J. Roy. Met. Soc.*, **76**, 312–30 (*July*, 1950).

Evidence is produced to support the belief that temperatures at the tops of weather echoes are indication of the relative strengths of the vertic currents within the echoes. Two types of weath echo are indicated according as the vertical currer are strong or weak, giving support to a theory f two different methods for the production of wat drops of raindrop size in the atmosphere.

551.551 : 551.5

8362. The quasi-static equations of motion wi pressure as independent variable. A. ELIASSE *Geofys. Publ.*, **17** (*No.* 3) 40 *pp.* (1950).

Starting with the quasi-static equations of atm spheric motion in Cartesian co-ordinates, pressure next introduced instead of height as an independe variable and the effect of the earth's curvature considered. Quasi-static perturbations of a weste current are treated and it is shown that the Solber Høiland stability criteria can be derived from th quasi-static theory without considering the earth curvature. Wave perturbations are considered the case of autobarotropy. A wind formula derived on the assumption that the wind is approx mately geostrophic. Finally, a possible method numerical weather forecasting, based upon the quas geostrophic approximation is suggested. R. S. REA

551.

8363. The affinity in thermodynamic processes meteorological interest. M. AZPIROZ YOLDI. *Re Geofis.*, **9**, 42–72 (*Jan.–March*, 1950) *In Spanish.*

By considering as different phases portions of th same ordinary phase which are at different pressu and/or temp. a formula for the affinity for evapor tion of water in moist, unsaturated air at a differe temp. is obtained. By applying De Donder's princip new differential equations are obtained for adiabat transformations of a closed system air-water-vapou and new definitions for equivalent and potenti equivalent temperatures are given. Following simil methods a formula for the radii of the drops steam fogs is obtained and the psychrometric equatic is discussed. M. DOPORT

551.573 : 551.508.7

8364. Some further considerations of the measur ment and indirect evaluation of natural evaporatio F. PASQUILL. *Quart. J. Roy. Met. Soc.*, **76**, 287–3 (*July*, 1950).

A previous observational study [Abstr. 5163 (1949 has been supplemented by further measurements evaporation and the associated vertical profiles wind velocity and vapour pressure in the first tw metres above a clayland pasture with grass moderate length, mainly in effectively adiabati conditions of flow. The evaporation measurement using a simple form of soil evaporimeter, include two series of statistically designed measurements, i order further to examine the "reliability" of th technique. The observed rates of evaporation (E_c are compared with those computed (E_c) from formula based on the Prandtl form of the law relatin drag and wind profile over a rough surface in adiabati conditions. The mean value of E_c/E_o is 0·99 an the individual deviations from 1·0 are within 1 20 and 30% in 24, 66 and 90% of cases. It is demon strated that deviations of this order are to be expecte from local variations in the various factors involve

rief consideration is then given to the validity and racticability of applying the above formula to vaporation from areas of growing crops. A.

551.573 : 551.55

365. Investigations of evaporation from pans. . YAMAMOTO. *Trans Amer. Geophys. Un.*, **31**, 349–6 (*June*, 1950).

The analogy between heat transfer and evaporation ields theoretical equations for evaporation from ans into still air and into moving air under turbulent nd laminar boundary conditions. It is found that mpirical equations obtained in a wind tunnel (using water surface covered by blotting paper to prevent praying) agree well with these theoretical results. he change between laminar and turbulent flow akes place suddenly and without any noticeable ransition at a certain critical Reynolds number. If he usual evaporation pan is used, however, as in Iillar's experiments, the water surface becomes urbulent even for small Reynolds numbers and the mpirical formula for evaporation is slightly different. A.

551.574

366. On the problem of condensation in the tmosphere. H. KÖHLER. *Nova Acta Reg. Soc. Sci. Ipsaliensis*, **14** (*No.* 9) 75 *pp.* (1950).

The value of recent investigations and points of iew on condensation of vapour in the atmosphere, articularly in the presence of hygroscopic con- ensation nuclei are analysed. Equilibrium curves etween vapour pressure and droplets of pure water nd the energy necessary for the formation of a roplet are obtained. The equilibrium of the droplet nd the energy necessary for its formation are obtained ith and without a condensation nucleus. Finally, he equilibrium condition for a system of droplets nd vapour is calculated. Non-hygroscopic nuclei, he kinetics of condensation and supercooling are iscussed. Numerical results for this theory are pplied and an application of the theory to the rmation of ground fog. R. S. READ

551.578.1 : 551.576

367. Experimental meteorology. V. J. SCHAEFER. *. angew. Math. Phys.*, **1** (*No.* 4) 217–36 (1950).

Conclusion of survey article [see Abstr. 7640 950)]. The modification of orographic and strati- rm clouds, of supercooled ground fogs and icing ouds, of orographic thunderstorms and of towering mulus are described; also the production of regions f ice nuclei in the sky; the potential precipitation ntained in clouds; the prevention of hail by seeding ethods. The apparent limitations to the modifi- tion of cloud systems are discussed. 28 refs.

551.578.11

368. Empirical formulae for the terminal velocity f water drops falling through the atmosphere. A. C. EST. *Quart. J. Roy. Met. Soc.*, **76**, 302–11 (*July*, 950).

From a consideration of experimental measure- ents of the terminal velocity of water drops and of the rag coefficient of rigid spheres it is suggested that a rmula of the type $V = A \exp bz\{1 - \exp[-(d/a)^n]\}$ ay be used to represent the terminal velocity of ater drops which are larger than those to which Stokes's law is applicable and which are falling through a standard atmosphere. If the drops have diameter less than 0·05 mm, Stokes's law is applicable and $V = Ad^2 \exp bz$. A.

551.593.12 : 612.84 : 525.722

8369. The scintillation of stars. H. HARTRIDGE. Letter in *Nature, Lond.*, **166**, 151 (*July* 22, 1950).

Goldie's explanation of this phenomenon (Abstr. 7646 (1950)] is shown to be incompatible with observed effects. R. A. WEALE

551.593.9 : 535.338.3

8370. On the origin of the sodium *D* lines during twilight. E. D. KAHN. Letter in *Phys. Rev.*, **79**, 167 (*July* 1, 1950).

551.594.21

8371. The free electrical charge on precipitation inside an active thunderstorm. R. GUNN. *J. Geophys. Res.*, **55**, 171–8 (*June*, 1950).

The free electrical charges carried on individual precipitation particles were measured in an electrically active thunder-cloud at various altitudes up to 20 000 ft, using an aircraft and an improved induction method of measurement that avoided touching the particles. Data are given for the free electrical charge measured on the droplets and for the droplet space-charge density at 7 different levels. Positive and negative charges were usually encountered at all levels, but sometimes only a single sign was observed in a specific area. With the freezing level at 14 000 ft, the maximum electrification occurred near 7 500 ft and at a temperature of + 10°c. Here both the positive and negative charge approximated 0·27 e.s.u. per drop. The charge per drop at 5 000 and at 20 000 ft was less than one-fourth of this value. The electric field at the surface of the observed highly-charged droplets is a large fraction of the dielectric strength of air, showing that powerful electrifying agencies exist. The distribution of free charge inside an active thunder-cloud is relatively complicated. A.

551.594.5 : 535.338.3

8372. Wave-length of the transauroral line of oxygen. N. D. SAYERS AND K. G. EMELEUS. Letter in *Phys. Rev.*, **79**, 166 (*July* 1, 1950).

551.594.51

8373. The intensity distribution within the nitrogen spectrum from canal rays and negative glow, with reference to the auroral luminescence. L. VEGARD AND H. RAASTAD. *Geofys. Publ.*, **17** (*No.* 7) 15 *pp.* (1950).

Experiments on the variation of intensity distribution of the negative N_2 bands obtained by exciting pure N_2, or a mixture of 10% N_2 + 90% He, at low pressure, with either neg. (cathode), or pos. (canal) rays, indicate the probability that the enhanced intensities of high v vibrational bands in high-altitude auroral spectra are due to excitation of N_2 by positive particles. From the mixture of solar corpuscles incident on the high atmosphere, pos. ions will be absorbed in the upper ionosphere (400–650 km), whilst electrons will penetrate down to 90–100 km. These latter will excite the rotational series of neg. N_2 bands whose intensity distribution, unlike that of the vibrational series, will remain sensibly constant, and thus may be used to obtain an upper limit to the temperature of the auroral region. D. R. BARBER

551.594.51

8374. The near-infrared spectrum of the polar aurora. W. PETRIE. *J. Geophys. Res.*, **55**, 143–52 (*June*, 1950).

Several infrared spectra of the aurora have been secured with a new spectrograph which gives a first-order dispersion of 40 Å/mm. Low-level permitted lines of O I and N I, and several N_2 bands belonging to the first positive group, are present in these spectra, while low-level forbidden and permitted lines of O II and N II are absent. Hence it is very unlikely that numerous faint features in the visible auroral spectrum, which Vegard has assigned to O II, really arise from this ion. The intensities of the O I lines indicate that the excitation temperature during an auroral display is of the order of 7 000°K. A comparison of the intensities of N I and O I lines indicates that a considerable fraction of the N_2 molecules have dissociated at a height of 60 miles. The first positive group of N_2 bands shows some structure, but higher resolution is required in order to measure the several maxima which are associated with these bands. The origin of a number of bands is u certain.

551.594.6 : 538.56

8375. A radio meteorological investigation in t south island of New Zealand. B. MILNES AND R. UNWIN. *Proc. Phys. Soc., Lond. B*, **63**, 595–6 (*Aug.*, 1950).

A Föhn wind blowing off-shore produces supe refraction at radio frequencies. This results in th guiding of very high frequency radio waves beyon the horizon in a radio duct close to the sea surfac The problems involved and the experimental tec niques adopted in a long term investigation of th phenomenon are described, and selected data a discussed. Field observations are presented in th form of isopleths of the relevant meteorologic quantities and of modified refractive index over th area under investigation, together with contours radio field strength for wavelengths of 300 cm, 60 cr 10 cm and 3cm, corresponding to the particul meteorological situations described.

BIOLOGY 57/59

MEDICAL SCIENCE
HUMAN PHYSIOLOGY 61

612.84 : 519.283

8376. On the use of Poisson's and Crozier's laws in the statistical interpretation of visual thresholds. E. BAUMGARDT. *C.R. Acad. Sci., Paris*, **230**, 2124–6 (*June* 12, 1950) *In French.*

The number of quanta required for the elicitation of a visual sensation as calculated from the Poisson function provides only an upper limit since it cannot separate receptor and stimulus fluctuations. But Piper's law shows that the minimum number of quanta is 2. The results of the former method are strongly affected by psychological conditions.

R. A. WEALE

612.84 : 525.722 : 551.593.12

The scintillation of stars. *See Abstr.* 8369

612.84 : 535.8

8377. The eye and optical instruments. A. ARNULF. *Čas. Pěst. Mat. Fis.*, **75** (*No.* 2) D178–D186 (1950) *In Czech.*

The physiological resolving power (r.p.) of the eye is compared with Airy's diffraction formula as applied to optical instruments: the two are found to be equal when the eye-piece has a diameter of 0·7 mm, the brightness of the test-object corresponds to 10^{-2} stilb, and the contrast is about 1. Curves relating the angular resolving power s of the eye and the diameter ω of the eye-piece at different (photopic and scotopic) brightnesses and contrasts, and others of the form $s\omega = f(\omega)$ are given: the latter show a minimum (optimum r.p.) corresponding to pupillary diameters of 0·6 to 0·8 mm under photopic conditions. This provides a theoretical foundation for empirical limits to the magnifications of telescopes and microscopes.

R. A. WEALE

612.843.1

8378. Rapid subjective examinations in optometr P. FLEURY. *Rev. Opt.* (*Théor. Instrum.*) **29**, 384–9 (*July*, 1950) *In French.*

An optometer is described in which the subje views 9 similar targets whose apparent distanc vary in steps of a $\frac{1}{4}$ dioptre. The near and far poin can usually be determined at one setting and th necessary corrections quickly found. Auxiliar lenses can be placed before the eye for subjects wit large refractive errors. With a suitable target, th axis and amount of astigmatism can also be dete mined. The choice of targets is discussed; a te chart having discrete bright points (each subtendin 1 or 2 mins of arc) arranged in diametral lines preferred. A graphical method of representing th results allows the form of the correcting lenses to b prescribed.

R. W. FIS

612.843.

8379. The effects of daylight and tungsten light adaptation on color perception. R. W. G. HUN *J. Opt. Soc. Amer.*, **40**, 362–71 (*June*, 1950).

A description is given of an apparatus which ha been used to investigate how the colour sensatio corresponding to a given stimulus changes as the stat of adaptation of the eye is altered. A limited series o results obtained with the apparatus reveals some ver striking changes in colour sensation as the adaptatio is varied. Most colours appear much more saturate to the light-adapted eye than to the dark-adapted eye and changes of hue also occur. The light-adaptin radiations used were the I.C.I. standard illuminants *A* and *B*, and their effects exhibited large differences A few adaptation and recovery curves plotted agains time are given, and indicate that photo-chemica rather than electrical processes are controlling th adaptation effects. The saturation effect is used t

deduce a picture of retinal processes in the light- and dark-adapted states. A.

612.843.3

8380. A method for calculating the effect of filters on colour vision. H. VON SCHELLING. *J. Opt. Soc. Amer.*, **40**, 419–23 (*July*, 1950).

The purpose of this paper is to calculate specimen curves which indicate in general how colours shift if a filter is applied. The first section contains the mathematical formulas. The method is used for studying the absorption by the macular pigment and by the intra-ocular media. The last example refers to the change in illumination from illuminant C to illuminate A and inversely. A.

612.843.612

8381. Perception of contrasts when the contours of details are blurred. A. M. KRUITHOF. *Philips Tech. Rev.*, **11**, 333–9 (*May*, 1950).

The contrast sensitivity S for white light is measured at a photopic and a scotopic brightness level. Plotted as a function of the angular subtend of the blurred interval I, S at the high brightness is constant up to $I \simeq 10'$, and then drops by 30%, remaining constant at least to $I = 40'$. The drop in the low-brightness measurements occurs at $I \simeq 20'$, amounting to 20%. No fixation point was used in either case. Graphs and diagrams of the experimental arrangements are given. R. A. WEALE

612.843.612

8382. On the role of the pupil diameter and the entoptic images in the perception of the contrast thresholds of the eye. A. ARNULF AND O. DUPUY. *C.R. Acad. Sci., Paris*, **231**, 244–6 (*July* 17, 1950) *In French.*

The relation between this threshold in the presence of entoptic images, C_i, measured with a fixed pupil, and the pupil diameter ω is $C_i = (C_0 + Q/\omega)(1 + A/\omega)$, where C_0, Q, and A are constants for different ω's. Their values are determined for 4 observers, the brightness is varied, and ω changed from 0·1 to > 2 mm. Reasons are given as to why the measured are systematically larger than the calculated values when $\omega < 0{\cdot}1$ and > 2 mm. Experimental difficulties are discussed: no fixation point was used. R. A. WEALE

612.843.63

8383. Researches on the dependence of the visual resolving power on luminosity and wavelength. M. HACK. *Atti. Fond. "Giorgio Ronchi,"* **5**, 129–32 (*June*, 1950) *In Italian.*

The visual resolving power is measured for two artificial stars, separated by twice their diameter and illuminated by a monochromator, the illumination being varied with a neutral wedge. At all wavelengths, the R.P. increases to a maximum with increasing luminosity. The variation with wavelength is less than expected from the Rayleigh criterion and at high luminosity levels the R.P. becomes nearly constant. R. W. FISH

612.843.721

8384. The cause of the Ronchi pseudo-stereoscopic effect in binocular observation of perspective through stenopaeic screens. D. TENDERINI. *Atti Fond. "Giorgio Ronchi,"* **5**, 133–41 (*June*, 1950) *In Italian.*

The pseudo-stereoscopic effect, obtained when looking through stenopaeic spectacles with circular holes, is shown to arise from the particular positions taken up by the eyes in their orbits, from the image displacements in the marginal zones of the eye, and from the limitations to the movement of the observer's head if the object is to remain in the visual field. R. W. FISH

612.85

8385. A dynamical theory of the cochlea. L. C. PETERSON AND B. P. BOGERT. *J. Acoust. Soc. Amer.*, **22**, 369–81 (*May*, 1950).

A hydrodynamical theory is given for a model of the cochlea. The model consists of two channels of varying but equal cross-sections. The channels are separated by an elastic membrane with variable dynamical constants. The two channels are interconnected at one end, and the entire structure is rigidly enclosed except for two accessible areas corresponding to the round and oval windows. The equations of motion, continuity including the effect of the membrane, and appropriate boundary conditions are formulated. As a first step toward a complete analysis the non-dissipative case is considered. Numerical solutions are found using experimental data obtained by G. v. Békésy. Localization phenomena and phase velocities are found to be in broad agreement with experimental data. A.

612.85

8386. Auditory sensation produced by "rectangular" waves. R. CHOCHOLLE. *Ann. Télécommun.*, **5**, 237–42 (*June*, 1950) *In French.*

The author concludes that the study of the sensation produced by "rectangular" waves indicates that the ear does not function as an analyser, with individual action of each component; on the contrary, the "global" form of the wave as well as its amplitude determine, solely, the sensation. It is observed that allowance must be made for the considerable distortion in the emission of complex waves. A. B. WOOD

612.85

8387. The acoustic pathways to the cochlea. E. G. WEVER AND M. LAWRENCE. *J. Acoust. Soc. Amer.*, **22**, 460–7 (*July*, 1950).

Measurements are made of the relative effectiveness of the round window as a route of entrance of sounds to the cochlea. When the ear is normal this route is of no importance, but when the middle ear apparatus is absent and its advantage is lost to the oval window route a sound will have nearly equal access by both windows. As phase and intensity relations between the two pathways are altered the potentials pass through maximum and minimum values, which for equal intensities of the two waves vary from a 6 db gain to a complete loss. Evidence is produced to show that each pathway of stimulation excites the same sensory cells and in the same intensity pattern. Over the major portion of the frequency range a minimum of response results when the waves are in phase as they enter the oval and round windows. Departures from this relation, which are most prominent at the highest frequencies, are explained as the result of reactance differences between the two windows. These results apply to the explanation of forms of deafness caused by interruption of the ossicular chain, and also to the explanation of the

treatment of otosclerosis by means of the fenestration operation. A.

612.85

8388. On the frequency limits of binaural beats. J. C. R. Licklider, J. C. Webster and J. M. Hedlun. *J. Acoust. Soc. Amer.*, **22**, 468–73 (*July*, 1950).

A theory of binaural beats is outlined, based on synchronous discharges in the two auditory nerves. Two sinusoids of frequencies f_1 (fixed) and f_2 (variable) were led separately to the two ears; and the difference $\Delta f = |f_1 - f_2|$ that marked the disappearance of the fluctuating loudness or roughness that is characteristic of binaural beats was determined. Δf was maximal (approximately 35 c/s) for frequencies in the neighbourhood of 400 c/s. Binaural beats were heard above 1 000 c/s, but careful attention was required and Δf was small. The theory, given to account for the fact that Δf is smaller both at low and at high frequencies than it is near 400 c/s, combines elements of the Hill–Rashevsky theory of the excitation of neurons with elements of Wever's volley theory. At low frequencies neurons can discharge in some degree of synchrony with the stimulus wave form, yet fail to coincide within the time interval necessary for synaptic summation. At high frequencies the neurons must take turns discharging, and relatively few can participate in any given volley. At intermediate frequencies, however, each neuron participates in many volleys and the neurons participating in each volley fire almost simultaneously. The result is that at intermediate frequencies synchrony is relatively precise in each afferent pathway and, when the two afferent streams join in a common neural centre beats appear. A.

612.85

8389. San Diego County Fair hearing survey. J. C. Webster, H. W. Himes and M. Lichtenstein. *J. Acoust. Soc. Amer.*, **22**, 473–83 (*July*, 1950).

A phonographically recorded test of the ability to hear pure tones was given to 3 666 people at the San Diego County Fair in the summer of 1948. The results were analysed according to the age, sex, musical training, and past noise environment of the listeners, and according to their statements as to whether or not they had difficulty in hearing. As expected, auditory sensitivity was found to decline with age; women were found to be more sensitive than men for the higher frequencies; and men who worked in noise showed greater than normal losses at high frequencies. The data indicated, in addition, that musically trained men and women possess greater hearing sensitivity than do men and women without musical training, and that the 20–29 year old males tested at San Diego in 1948 appeared to have a greater loss at the high frequencies than did most males of the same age group who were tested in surveys before the war. A.

612.85 : 534.792

8390. The frequency selectivity of the ear as determined by masking experiments. T. H. Schafer, R. S. Gales, C. A. Shewmaker and P. O. Thompson. *J. Acoust. Soc. Amer.*, **22**, 490–6 (*July*, 1950).

The results of experiments on masking of tones by narrow bands of noise at 200, 800 and 3 200 c/s are presented. These are interpreted in terms of the critical band hypothesis. Assuming a simple resonant characteristic for the aural frequency selectivity the shape of the masking *vs.* frequency function is computed and gives a reasonably good fit in the narrow regions studied. The critical band widths are determined at frequencies 200, 800 and 3 200 c/s, and the corresponding values of Q of the equivalent tuned circuit are given. Data are presented for masking of tones slightly removed from the masking noise band, and are shown in fair agreement with the computed values. The selectivity curves are shown to be consistent with available data on differential sensitivity to frequency. A.

612.85 : 534.83

8391. Individual differences in noise masked thresholds. J. C. Webster, M. Lichtenstein and R. S. Gales. *J. Acoust. Soc. Amer.*, **22**, 483–90 (*July*, 1950).

Absolute thresholds and thresholds of pure tones masked by thermal noise were obtained for 3 666 persons attending the 1948 San Diego County Fair. The masked hearing losses as well as the absolute hearing losses (1) increased with an individual's age, (2) were positively correlated with his awareness of hearing difficulty, and (3) were inversely related to his musical training. Masked losses, however, were less dependent upon one's sex and upon one's past noise environment than were absolute losses. When groups of individuals were equated as to their absolute losses on 880 c/s and 3 520 c/s (the frequencies which were masked), that part of each group that had the lower absolute thresholds on 440 c/s also had the lower masked thresholds. The signal to noise ratio (noise expressed as spectrum level) at masked threshold for those with no absolute loss was 20 db at 880 c/s and 21 db at 3 520 c/s. This is equivalent to saying that the noise bands which were effective in masking these frequencies were 100 and 128 c/s wide, respectively. A.

615.849

8392. Some simple methods of isodose contour projection for symmetrical and unsymmetrical fields. J. L. Howarth. *Brit. J. Radiol.*, **23**, 358–67 (*June*, 1950).

An apparatus for graphical projection of X-ray isodose curves into a plane at an angle to the X-ray beam (necessary during X-ray "planning"). For symmetrical fields, projection of each point of the original curves to another plane at a given angle requires one linear and one circular geometrical construction (Wilson 1940). Here, a base sheet of Perspex, scribed with concentric circles at $\frac{1}{2}$ cm intervals affords the latter, 2 pivoted straight edges the former, part of this construction. The original isodose curve, and paper for its projection, are held by Perspex clip between base sheet and straight edges. The apparatus has the advantage of being plane and is laid on a horizontal viewing box for illumination. A simpler modification, in transparent film base, is also described. For unsymmetrical X-ray fields, isodose curve projection requires 3 linear geometrical constructions. The apparatus is again of Perspex, 2 pivoted, graduated set-squares moving over a grid ruled with $\frac{1}{2}$ cm-spaced parallel lines and on which the central axis isodose curve and tracing paper are mounted. Isodose curves projected by this method

are estimated to take 10 minutes for symmetrical, 30 minutes for unsymmetrical beams. D. V. MABBS

615.849 : 537.531

8393. A note on the calculation of dose in X-ray fields. M. J. DAY. *Brit. J. Radiol.*, **23**, 368–9 (*June*, 1950).

Facilitates calculation of isodose curves for rectangular X-ray fields in light-atom media, using only central-axis depth dose tables. Follows methods of Meredith and Neary and Clarkson in dividing the field into sectors and summing their contributions. The field is divided into 4 parts by lines parallel to each side: there is, in the rectangles so formed, a common corner P. Contributions to radiation vertically below P come from these 4 rectangular "beams." Taking each rectangle in turn, P can be made the centre of an area 4× as large. Central-axis depth doses applicable to a field of this latter area will therefore, divided by 4, give the contribution from the original segment down an axis through P. Thus, the total dose on this axis is one-quarter of the added central axis doses for the 4 component rectangles in the beam section. Tables are included giving "equivalent circle" fields [Abstr. 6640 (1949)] for any shape and size of rectangle, so that central-axis depth doses for circular fields only are required.

D. V. MABBS

615.849 : 537.542

8394. A probe type direct reading dosage-rate meter. R. C. TURNER AND S. P. NEWBERRY. *Brit. J. Radiol.*, **23**, 424–9 (*July*, 1950).

A direct-reading probe type dosage-rate meter suitable for radium or X-ray measurements inside the human body is described. The instrument utilizes an "air-walled" chamber of 0·07 cm³ volume together with a miniature thermionic electrometer system, the whole comprising a probe which may be shaped to specific requirement and be readily capable of insertion into the major body cavities. The electrometer output is conveyed by a flexible multi-cored cable of any desired length to the amplifying and indicating system which may be housed at any convenient distance. The most sensitive range of the instrument gives full-scale deflection for 5 *r*/min, but the sensitivity is easily adjustable from this figure up to several hundred *r*/min, if required. Standard components are used throughout, the electrometer system being comprised of miniature radio valves. A.

616–073.75 : 778.33

8395. Phantom tests with X-rays. G. C. E. BURGER. *Philips Tech. Rev.*, **11**, 291–8 (*April*, 1950).

Following an introduction concerning the factors affecting an X-ray image, the construction is discussed of some phantoms enabling the merits of various radiologic methods to be compared. Some applications of these phantoms are dealt with: comparison of the properties of X-ray apparatus in different institutions, selection of doctors and others for X-ray screening, investigation into the influence of enlargement of the X-ray image, and the effect of movement of the object upon the X-ray image. Finally a phantom of smaller dimensions is described which serves for the regular checking of lung radiographs, which is particularly of importance when several radiographs have to be made of the same patient. A.

616–073.75 : 778.33 : 77.036

Recent developments in medical photography and radiography. *See Abstr.* 8401

TECHNICAL MATERIALS 66/67

666.1.037.5 : 539.4.016

8396. The physical aspect of glass–metal seals in the electron tube industry. I. G. TRÉBUCHON AND J. KIEFFER. *Ann. Radioélectricité*, **5**, 125–49 (*April*, 1950) *In French.*

Stresses in glass–metal seals at ordinary temperatures are due to (*a*) incomplete annealing at higher temperatures and (*b*) differences in the properties of the glass and the metal. Dilatometric measurements are useful for finding annealing schedules but fail to take account of size and elasticity factors which are important under (*b*). It is shown how the use of a polarimeter with standard specimens can yield quantitative data on the maximum stress and its variation with size and temperature on condition that the Young's modulus of both materials and the photo-elastic coefficients (Brewster's constant) of the glass are known independently. Experimental results are given for 3 types of glass–metal join.

R. O. DAVIES

666.1.056.5

8397. A method of making glass-metal seals. N. A. ECKSTEIN, J. W. FITZGERALD AND C. A. BOYD. Note in *Rev. Sci. Instrum.*, **21**, 398–9 (*April*, 1950).

669 : 539.16

8398. Formation of radioactive surface films on minerals. T. G. CHURCH. *Canad. J. Res. A*, **28**, 164–7 (*March*, 1950).

With the requisite chemical treatment, specific minerals will assume a surface radioactivity by undergoing reactions with radioactive ions in solution. It is essential that the mineral have a suitably tarnished or coated surface, for in general no exchange will occur on a fresh surface. It is suggested that the radioactivity so induced could be used in conjunction with a mechanical device to separate and concentrate the valuable minerals in an ore, or to control hydrometallurgical plant processes. A.

669.018 : 541.123.3

8399. The quaternary system aluminium–iron–cobalt–nickel, with reference to the rôle of transitional metals in alloys. G. V. RAYNOR AND M. B. WALDRON. *Proc. Roy. Soc., A*, **202**, 420–38 (*Aug.* 7, 1950).

The results of the investigation confirm previous suggestions [Abstr. 3056 (1948)] that the intermetallic compounds formed by Al and transitional metals may, if sufficient Al is present, be regarded as

analogous to electron compounds, with absorption of electrons by the transitional metal atoms occurring. The theory may be used, in favourable cases, to predict quantitatively the forms of uninvestigated complex equilibrium diagrams. In the present case, equilibrium relationships in a quaternary system have been predicted from those in the 3 subsidiary ternary systems, 2 of which were themselves largely predicted as a result of the original theoretical interpretation of the Al–Fe–Ni alloys. A.

PHOTOGRAPHY 77

77.023

8400. Comment on the work of K. Kumetat: On a new class of developers. E. BUCHTA. *Z. wiss. Photogr.*, **45**, (*No.* 4–6) 94–5 (1950) *In German.*

Kumetat's statement [Abstr. 1618 (1949)] that α-picoline will not condense with *p*-quinone is incorrect. S. T. HENDERSON

77.036 : 778.33 : 616–073.75

8401. Recent developments in medical photography and radiography. W. WATSON. *Photogr. J., B.*, **90**, 72–80 (*May–June*, 1950).

A brief review is given of some radiographic and photographic methods used for arresting motion and for motion analysis. The use of condenser discharge pulse-controlled circuits is described, both for single and rapid sequence exposures. A new circuit for radiography includes a three-electrode h.t. switch valve and smoothed h.t. current triggered by a kine camera contact or by a watt-seconds timer. Stereography and stereophotography with parallax line or lenticular screens is described, as well as the use of such screens for purely motion records. Mention is made of a modified form of grid for X-ray kymography. Optics for screen photography (indirect radiography) can be designed for curved surfaces; a new mirror lens designed for cylindrical object and film surfaces has been made. Motion analysis of eye movements is dealt with, and an account is given of a recent revival of the author's machine for sectional radiography in the horizontal plane. A.

771.31 : 778.37

8402. A multiple Kerr-cell camera. A. M. ZAREM AND F. R. MARSHALL. *Rev. Sci. Instrum.*, **21**, 514–19 (*June*, 1950).

The need for new ultra-high speed photographic techniques in studies of brief transient phenomena has led to the development of a multiple Kerr-cell camera designed to take a sequence of 3 photographs at sub-microsecond exposure times. This camera uses shutters of the electro-optical type utilizing the Kerr effect in nitrobenzene. Pulsing networks for the Kerr cells and synchronizing networks for the entire system are described. The system has shown itself to be capable of high shutter speed, high sequence rate, and very good stability of timing. With this camera, routine studies of electrical discharges at effective exposure times of 0·04 μsec and framing rates corresponding to 40 000 000 frames per sec have been made. It is felt that cameras of this type are valuable research tools that will help open the way for further important studies. A.

771.35

8403. The progress of wide-aperture photographic objectives. B. SEEGERT. *Z. wiss. Photogr.*, **45** (*No.* 4–6) 95–118 (1950) *In German.*

A review of photographic lens design from the earliest landscape lenses to the present day wide-aperture systems. A comparison of some mirror systems (Schmidt, Bouwers, etc.) is given. Possible applications of the new "heavy" optical glasses are discussed. 17 references are given. R. W. FISH

771.5 : 537.533.72

8404. Electron microscope study of nuclear emulsions. G. BARONI AND C. CASTAGNOLI. *Nuovo Cim.*, **7** (*No.* 3 *bis*) 364–71 (*May*, 1950) *In Italian.*

The form and the size of the AgBr grains and the development process in some photographic plates for nuclear researches were observed with an electron microscope (18 000 × mult.). A.

771.5 : 539.172

8405. A new method for preparing "sandwich" emulsions for nuclear physics: advantages over the method of impregnation. L. VIGNERON AND M. J. BOGAARDT. *J. Phys. Radium*, **11**, 283–7 (*June*, 1950) *In French.*

In preference to methods employed hitherto, the radioactive element to be studied is introduced between two layers of nuclear photographic emulsion. This "sandwich" layer consists of a gelatin suspension of insoluble particles of the substance, average particle size ~ 1 μ. The 3 layers are thermally bonded at 45°c. The following advantages are claimed: (i) as the *p*H of the emulsion is not affected, chemical deterioration is avoided, (ii) nuclear reactions under examination will not be masked by side reactions with elements present in the emulsion layers, (iii) the points of origin of fission tracks are exactly located. D. R. BARBER

771.53

8406. Sensitometry of some photographic emulsions of astrophysical interest. P. GUERIN AND G. DE VAUCOULEURS. *Ann. Astrophys.*, **13**, 203–8 (*April–June*, 1950) *In French.*

Sensitometric properties of 23 photographic plates and films by different makers (including blue- and red-sensitive types) have been tested by exposing in a tube sensitometer through colour filters, and processing in a M.Q. developer. Exposure times ranged from 3 to 30 min. Effects of storage period previous to exposure (up to 8 years from manufacture) on speed, gamma and chemical fog, and of hypersensitization with NH_3 have been investigated also. D. R. BARBER

771.53 : 539.16

8407. A new photographic material—a high-resolution emulsion for autoradiography. R. W. BERRIMAN, R. H. HERZ AND G. W. W. STEVENS. *Brit. J. Radiol.*, **23**, 472–7 (*Aug.*, 1950).

The new material consists of a glass support carrying a strippable 10 μ gelatin layer which carries on its upper surface a 4 μ thickness of fine grain "concentrated" emulsion (i.e. as used for nuclear track recording). For use, the composite gelatin emulsion layer is stripped off, floated on to the specimen whose autoradiograph is required, dried down, and exposed, processed, and examined with the emulsion in optical contact with the specimen. Estimates of the sensitivity of the emulsion are given in terms of the number of electrons incident per cm^2 to give a photographic density of 0·5 above fog and of the grain yield per incident electron using P^{32} and I^{131} as radioactive sources. The resolving power was measured by making auto-radiographs from radioactive test charts, and gave a value of at least 200 lines/mm. A.

771.534.533

8408. Comment on the paper by J. M. Keller, K. Maetzig and F. Möglich: On the kinetics of the photographic development process with special reference to fast-working combined developer-fixers. A. HAUTOT. *Ann. Phys., Lpz.*, 7 (*No.* 1–2) 110–12 (1950) *In German.*

See Abstr. 1139 (1948). The German authors misunderstood the views of Hautot and his colleagues owing to ignorance of work published during the war. Further comments are given by Möglich, and (in French) by Hautot. S. T. HENDERSON

771.534.56 : 778.34

8409. Deviations in the reciprocity law in the photographic effect of electrons. I. A. KOVNER. *J. Exp. Theor. Phys., USSR*, **20**, 401–10 (*May*, 1950) *In Russian.*

Films were irradiated with electrons of medium energy; the intensity of the beam and the sensitivity of the film were varied within wide limits. It was found that for all the films investigated there are two ranges: one of low and one of high intensity, for which the law of reciprocity is valid; and an intermediate range, where appreciable deviations occur. A qualitative explanation of the phenomenon is suggested. B. F. KRAUS

778.3

8410. The photographic emulsion in nuclear physics. H. DE VRIES. *Ned. T. Natuurkde*, **16**, 127–36 (*June*, 1950) *In Dutch.*

Deals mostly with the use of photographic emulsions for recording the tracks of ionizing particles. The requirements which such emulsions should satisfy are outlined and an indication is given of the use of these emulsions in the recognition of types and energies of particles from the types and lengths of their tracks. A brief mention is also made of autoradiography. J. THEWLIS

778.3 : 531.787

8411. Recording of slow development of phenomena on sunlight paper. R. LEGENDRE AND R. HOUARD. *C.R. Acad. Sci., Paris*, **230**, 725–6 (*Feb.* 20, 1950) *In French.*

The object of the apparatus is to record the variation with time of the Hg level in a number of manometers, so as to investigate the flow of air round an obstruction. An intense beam of parallel light from a Hg arc falls on each manometer, and a shadow is formed by the mercury column. An exposure time of 1 sec is sufficient; the paper is then moved and another exposure made. The period of oscillation of the mercury in the manometer is large compared with the exposure time, so the method is limited to fairly slow trends. N. CORCORAN

778.3 : 539.16.08 : 537.591

8412. Possibilities and limitations of the photographic method in nuclear physics and cosmic radiation. M. BLAU. *Acta Phys. Austriaca*, **3** (*No.* 4) 384–95 (1950) *In German.*—A review. W. F. BERG

778.33 : 537.533.72

8413. The intensification of the fluorescent image in radiology. F. I. G. RAWLINS. *Brit. J. Radiol.*, **23**, 460–4 (*Aug.*, 1950).

The condition to be satisfied is that of intensification over a "scene" comprising an area of several square inches at least. It is impossible to achieve this by optical means alone. Therefore, some types of image-convertor tubes have been devised. Three are described, and are shown to produce an intensification of some five-hundredfold at the most, thus bringing fluoroscopic observations to a brightness of around 0·1 millilambert. In conclusion, the potentialities of television pick-up devices and the problem of remote viewing are discussed. A.

778.33 : 537.533.8

8414. Observations concerning the secondary electronic emission from certain materials by means of its photographic action. C. W. WILSON. *Brit. J. Radiol.*, **23**, 478–84 (*Aug.*, 1950).

Experiments are described which were designed to examine how the photographic blackening, due to the secondary electronic emission generated in materials by 200 kV X-rays, depends upon the material. It was found that with the exception of S, the photographic blackening varied smoothly with atomic number for elements of atomic number from 6 to 29. The blackening due to S was, for some unknown reason, anomalously low. The blackening due to a number of more complex materials of radiological interest (various plastics, amber, bone and conducting, pressed bakelite materials) was similarly examined. For most of these the blackening was close to what would be expected from their theoretical effective atomic numbers. That due to bone, however, corresponded to a much lower effective atomic number than has been found by other methods. The blackening due to distrene was greatly in excess of what could be due to secondary electronic emission. It was thus found that distrene fluoresces visibly when irradiated with X-rays. A.

778.33 : 539.163

8415. An autoradiographic method for studying segregations in steels. A. KOHN. *C.R. Acad. Sci., Paris*, **230**, 2201–3 (*June* 19, 1950) *In French.*

Autoradiography has been applied to the study of segregations in steel. The effective radio-isotope can either be introduced in a rich alloy during the making

of the melt, or be produced in the steel by direct irradiation of a sample in a nuclear reactor. Promising results have been obtained. G. O. BAINES

778.34

8416. Stopping power of nuclear emulsions for ionizing particles. H. G. DE CARVALHO. *An. Acad. Brasil. Cienc.*, **22** (*No.* 1) 73–6 (1950).

All available data on the stopping power of photographic emulsions towards nuclear charged particles have been combined in a single graph, to show that the empirical equation $S = R_0/R = A\beta^k$ is fulfilled with an accuracy of 2%. S = stopping power, R_0 and R = ranges in dry air and emulsion respectively, A and k are constants of value 2·760 and 0·157 respectively, $\beta = v/c$. The range of β-values covered is from 0·035 to 0·28 for protons, alpha-particles and fission fragments, and for electrons with lesser accuracy from 0·3 to 0·8. W. F. BERG

778.34

8417. The study of atomic processes with the photographic plate. H. K. HEITLER AND D. T. KING. *Experientia*, **6**, 281–90 (*Aug.* 15, 1950).

A semi-popular review covering the characteristics of tracks of nuclear particles recorded directly in photographic emulsions and applications to cosmic radiation, geology and autoradiography of biological specimens. W. F. BERG

778.34 : 535.33

8418. The radioactive intensification of spectral lines. S. ROSENBLUM. *C.R. Acad. Sci., Paris*, **230**, 1766–7 (*May* 15, 1950) *In French.*

If a photographic deposit is intensified by means of the ordinary U intensifier, the radio-activity of the U could be utilized to produce an impression on a piece of photographic material in contact with the image. With ordinary U it would take several months to produce an impression which is stronger than the original. By using Pu 239, however, a useful result could be obtained within 30 minutes. W. F. BERG

778.53 : 537.533.72

8419. A technique for taking motion pictures of electron microscope images. L. E. PREUSS AND J. H. L. WATSON. *J. Appl. Phys.*, **21**, 902–3 (*Sept.*, 1950).

The technique is proving useful in the study of some of the effects of electrons upon matter and particularly upon colloidal crystals. Resolution of 150 to 300 Å is achieved and is suitable for many practical electron microscopical problems. Pictures are taken from outside the instrument, utilizing the radiation emitted by the fluorescent screen. Some instrument adaptation is required for adequate illumination, and precautions must be exercised against toxic X-ray dosages. A.

778.

8420. Principles of color sensitometry. *J. Soc Mot. Pict. Televis. Engrs*, **54**, 658–724 (*June*, 1950).

A report reviewing the functions of colour sensitometry, its fundamental concepts and their approximat realization in practice. Subtractive processes used in films are alone considered. Sensitometric exposures instruments giving exposures of constant time a varied light intensity are recommended in view of th complex conditions affecting the reciprocity law an development in colour films; photographic ste wedges are preferable to colloidal graphite ones both a grey scale and selective exposures of th separate layers are desirable, while spectral com position of the light used is important. Processing o sensitometric tests: the difficulty of matching result from routine processing with those from controlle tests is discussed; instead of checking film charac teristics, processing itself may be controlled by use o a standard emulsion, but precision is difficult Quantitative evaluation of the image: terms describing different types of density are discussed in detail, the main classification being into integral densities referring to absorptive action of the film as a whole and analytical densities referring to composition o the dye images. In the first class, the densitometer may give red, green and blue printing densities applying to the print material used, or colorimetric densities by use of the $\bar{x}$, $\bar{y}$ and $\bar{z}$ functions, or luminous densities from $\bar{y}$ only; even arbitrary colour filters are useful within limits; spectral densities giving a complete absorption curve provide the most complete information; among analytical densities, spectral measurements at one wavelength for each dye can provide corrections to faulty colour balance. Equivalent neutral densities are much used, especially in tone reproduction problems; systematic errors in analytical densities are considered. Densitometer design principles: current types are described, with sections on the component units; diagrams show typical assemblies for integral and for analytical determinations. Transformations between integral and analytical densities: examples of computations are given, assuming monochromatic measurements; errors are introduced by the use of finite wavebands, and by additional light losses in the film due to stains or reflections. Interpretation of sensitometric results: the uses and limitations of sensitometry are discussed, with reference both to the adjustment of processing and printing to a satisfactory state, and to their subsequent control in this condition; sound tracks may also be controlled by sensitometry. Subjective judgments are indispensable in the adjustment stage. Statistical aspects of colour sensitometry: brief treatment of methods of studying variations in densitometer results. 34 *references* end the report.

S. T. HENDERSON

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